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MASSACHUSETTS INSTITUTE OF TECHNOLOGY

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DECEMBER, 1929

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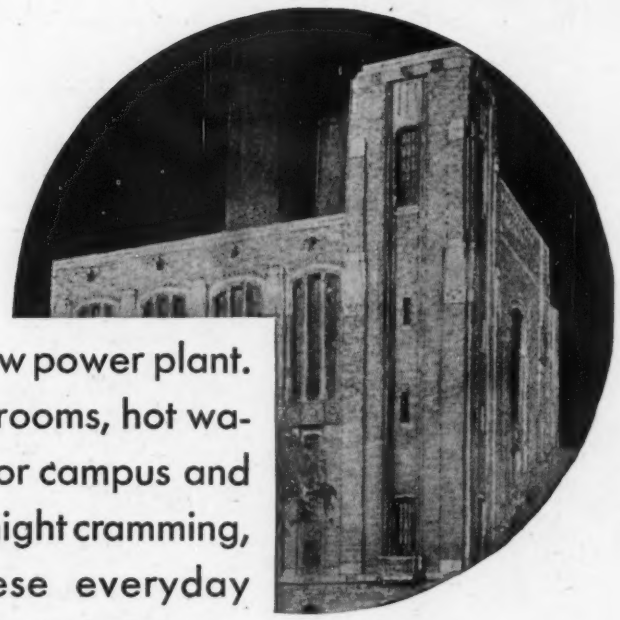

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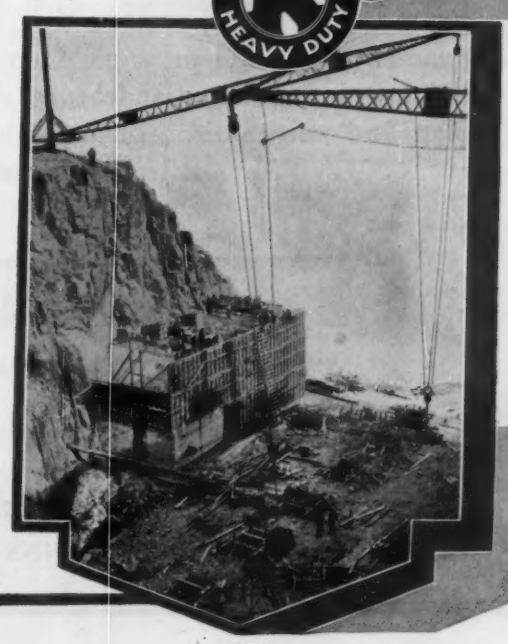

The revised edition of "Concrete — Its Manufacture and Use," a complete treatise and handbook on present methods of preparing and handling portland cement concrete, is now ready for distribution. To engineering students, faculty members and others interested we shall gladly send a copy on request.

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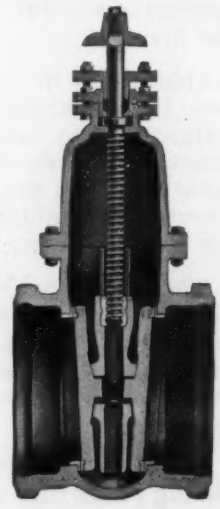

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WHAT YOUNGER COLLEGE MEN ARE DOING WITH WESTINGHOUSE

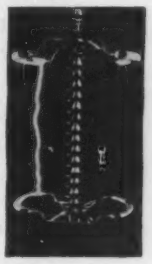
LIGHTNING HAS LONG BEEN A COSTLY RAIDER OF POWER LINES

Wild lightning meets his master . . .

REMEMBER how you used to sit on the porch during a thunderstorm and shudder just a little at the forces that seemed to tear open the sky and shake the hills? Electrical men have often shuddered in grave seriousness over those same forces. For lightning has been a costly raider of power lines.

Now, however, many means of defense are available, and many more are being developed. Science has been studying lightning, and experimenting with it. Down in the mountains of Tennessee a group of Westinghouse men have been making photographic records of the voltages developed by lightning, with the cathode-ray oscillograph and the klydonograph. Guided by their findings another group in New Jersey is enabled to reproduce lightning artificially, and study its effects on a high-tension line. And in East Pittsburgh, with a generator that will produce lightning strokes equivalent to 35,000,000 horse-power and with a laboratory that duplicates power line conditions, others are learning new facts about the behavior of protective devices.

Much of this work is carried on by young men recently out of college. Their achievements will save millions for power companies, and eliminate many hazards to life in sub-station operation.



Lightning jumps the gap between these Westinghouse arcing horns, and spares the insulators.

Westinghouse

"Much mail today; too much work for my burro"

"SUS cartas de hoy son muchas; el trabajo demasiado para el burro!" exclaimed the Mexican postman as he dumped a bulging mail-sack from his pack saddle.

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Among Our Authors

FEW men are better qualified than Harry D. Peck '13 to write for M. I. T. readers on "Opportunities in Patent Law." After graduation from the course in Mechanical Engineering, he studied patent law at night in Northeastern University, while working for an industrial concern. At present, he is actively engaged in the pursuit of his profession, and, in this position, can give the undergraduate a true picture of its possibilities. Students in the journalistic activities at M. I. T. are familiar with him through his connection as a member of the Advisory Council on Undergraduate Publications.

GLASS That Glows in the Dark" is but one of a number of articles dealing with work which Prof. Donald C. Stockbarger has been doing in the Radiation Laboratory. He graduated from the Institute in 1919 and has been a member of the Institute staff in the Department of Physics since that time. Ultra-violet radiation and the quartz mercury arc are problems upon which he has centered attention.

ALTHOUGH he has been on the instructing staff at M. I. T. for but a comparatively short time, Professor Morris brings with him a wealth of valuable experience that forms a background for "Geology for Engineers." From 1914 until 1920, he was at Columbia University, and then, during the next two years, he established a department of geology at Pei Yang University at Tientsin, China. He then held a position as research associate on the staff of the American Museum of Natural History, and was one of the two geologists on the Central Asiatic Expeditions led by Roy Chapman Andrews in 1922, 1923, and 1925. For the past two years, he has been a member of the Department of Geology here at the Institute, giving courses in structural geology and economic geography.

AFTER taking degrees of B.S. and M.S. from the University of Maine, Raymond D. Douglass served in the Navy as an ensign during the World War, making application of his advanced study in mathematics. Since 1919, he has been in the Department of Mathematics at Technology. A large part of his time is spent on the solution of problems which are sent to the Institute by outside interests, and a number of his methods are those outlined in "Graphical Solution of Engineering Problems."

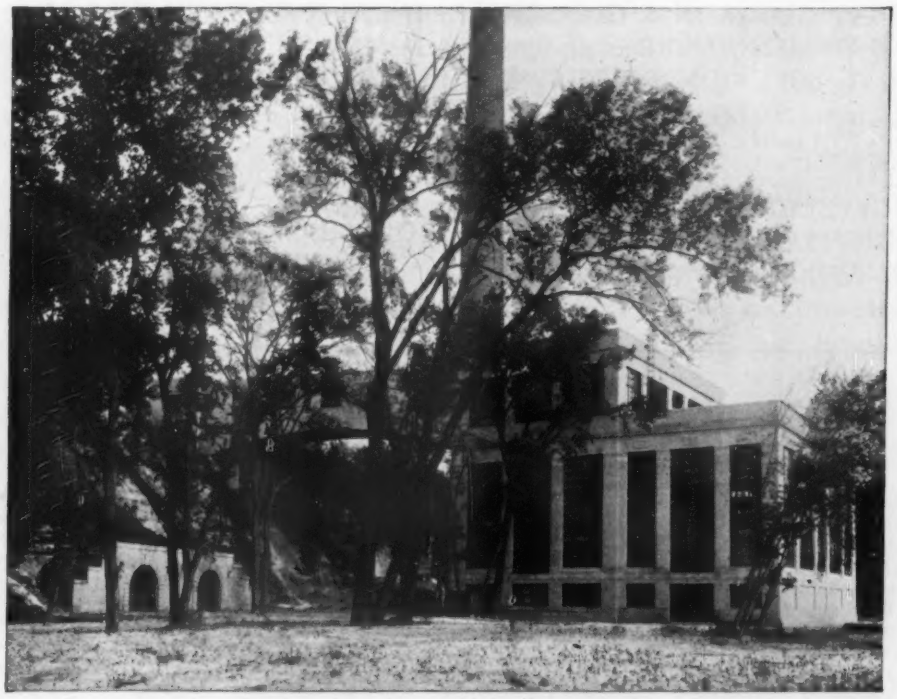
PROF. H. W. UNDERWOOD, JR., author of "Nitrocellulose — A Product of Many Uses," took his bachelor's, master's, and Ph.D. degree at Brown before coming to the Institute in 1920 in the Department of Chemistry. Numerous technical publications of his work deal with catalysis in applied organic chemistry and investigations in the theoretical phases of the pure science. He is the author of two textbooks in organic chemistry, and at the present time, is giving graduate courses in catalysis and industrial organic chemistry.

RECENT INDUSTRIAL POWER STATIONS

RECENT industrial power stations completed or in progress include work for the following clients: Vacuum Oil Company, Atmospheric Nitrogen Corporation, National Carbon Company, Inc., Pittsburgh Plate Glass Company, S K F Ball Bearing Company, American Sugar Refining Company, Mathieson Alkali Works, Inc., Bethlehem Steel Company, Westinghouse Lamp Company, United States Rubber Company, The Flintkote Company, Pacific Coast Condensed Milk Company, Standard Underground Cable Company, Firestone Tire & Rubber Company.

The work is varied. It includes the building of new steam and power stations, increasing the capacity of present plants, revamping present equipment to meet demands of economy, and rehabilitating old plants.

Illustrated is the Twin Cities Steam Power Plant of the Ford Motor Company at St. Paul.



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THE PROFESSIONAL JOURNAL OF THE UNDERGRADUATES OF THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY

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OPPORTUNITIES IN PATENT LAW

Combining phases of the legal and engineering professions, the patent attorney has a most interesting field

By HARRY DEXTER PECK '13
Counsellor at Patent Law

THERE are many things an engineer can do. Many are his interests, and broad is his field. But the thought of an engineer making a success in the field of patent law seems to some, at first, highly improbable. An engineer is not trained in abstract law. He deals with exact science, the hard facts of life. He interprets the laws of nature, not the laws of man. Hence, one asks, where is the connection between engineering and patent law? To answer this question it is first necessary to present a picture of the true meaning of Letters Patent and Patent Law.

Patent Law deals with the rights growing out of the grant of Letters Patent by the government. When the framers of our federal constitution prepared that wonderful document, they provided that Congress should have the power to promote the progress of science and useful arts by securing for limited times to inventors the exclusive right to their respective inventions or discoveries. In pursuance therewith, Congress in 1790 inaugurated the patent system of the United States and imposed upon the Secretary of State, the Secretary of War, and the Attorney General, or any two of them, the duty of granting Letters Patent. Later this duty was confided in the Secretary of State coupled with the approval of the Attorney General. In 1836 a sub-department of the State Department was created to be known as the Patent Office. This office was transferred in 1849 to the Department of the Interior and there it remained until, during President Hoover's regime as Secretary of Commerce, the Patent Office was placed under his jurisdiction. At the time of this writing, 1,735,841 original Letters Patent have been issued in this country. About one thousand patents are now being issued weekly. Since January 1, 1925 over four hundred thousand applications for Letters Patent have been filed, a rough average of two thousand a week. In spite of the natural feeling one might entertain that there is little left to be invented, the fact is that more applications are being filed each year, and more Letters Patent granted, than ever before. The curve is ever rising and its rate of climb appears to increase.

Letters Patent are granted by the Patent Office for new and useful inventions. The inventor must make application in due form, setting forth in detail the nature of his invention and illustrating clearly the most desirable manner in which he has contemplated applying the principles of his invention, whenever the nature of the case admits of drawings. He must also claim his invention, that is, he must particularly point out and distinctly claim the part, improvement, or combination which he claims as his invention or discovery. It is the claims of a patent which really make or break the document. They are the formal statements by which the inventor seeks to establish the boundary of his monopoly. If too broad — too inclusive — they will be either rejected by the Patent Office or, if allowed by that tribunal, they will later be declared invalid by a Court; if too narrow, the claims will fall short of giving adequate protection to the inventor. The drafting of valid and sufficiently protecting patent claims is an art and is a task of considerable importance because, as before stated, it is the claims which define the scope of the patent monopoly.

After the application is presented to the Patent Office it is assigned to the division in which its invention is classified and there most critically examined. The Examiners endeavor to find some anticipation of what is claimed, it being fundamental, of course, that anything old or previously known cannot be claimed by a later inventor. The Examiner can cite any prior United States or foreign patent or any prior printed publication as an anticipation in rejection of the claims. In accordance with the rules of practice, the applicant has the right to amend his claims

(*Continued on page 378*)

Glass That Glows in the Dark

The luminescence of special glasses gives an insight into their permanence

By DONALD C. STOCKBARGER '19
Assistant Professor of Physics
Massachusetts Institute of Technology

RECENTLY in the Proceedings of the Royal Society of Canada[1] there appeared the announcement of a discovery which is destined to be of rather far-reaching importance, *viz.*, that a certain kind of window glass after being exposed to sunlight exhibited a very strong luminescence when examined in the dark. The value of the discovery does not lie in the remote possibility that houses are to be illuminated at night by the energy which their windows have stored up during the day time, for although the light was very strong when considered as luminescence it was too weak for purposes of illumination. On the contrary, it helps to clear up some misunderstandings concerning the admission of sunlight into our homes.

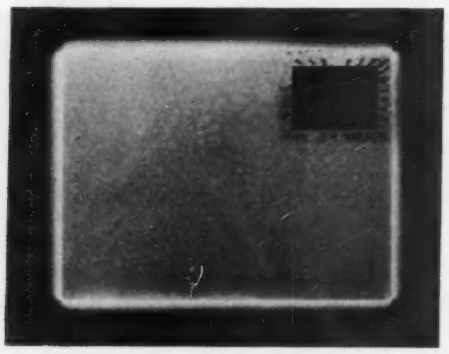


FIG. 1. LUMINESCENT GLASS

Photograph of a specimen of special window glass made with its own light in a dark room.

These glasses are some of the materials which were placed on the market a few years ago as substitutes for quartz so that hospitals and private estates of limited means could enjoy the well-known benefits of all the ultraviolet rays of sunlight. The public, not understanding the nature of ultraviolet radiation and being continually misled by certain false rumors, has not accepted these substitutes as whole-heartedly as they deserve. Yet the public has had the essential facts thrust upon it time and again in the form of magazine articles and lectures by authorities on ultraviolet, so that there is no excuse for the ignorant notion that ordinary windows are opaque to all of these rays. Perhaps if we were not living in such a realistic age as ours is, the public could be made to understand that ultraviolet is simply a name for a great family of radiations which, although related, are different in character. A host of the solar ultraviolet rays pass through common window glass as easily as through quartz; only a few are completely stopped. But what a difference a few rays make if, as is the case here, they happen to be the ones which are responsible for tan and various other benefits ascribed to sunshine!

There are two ways of extending the transmission of glass toward shorter wave-lengths so as to include the tanning rays. The first and perhaps easiest way is to decrease its thickness. Even common glass if paper-thin rivals quartz of the usual window-glass thickness. Safety, however, requires a moderately heavy glass so that a limit is quickly reached in this direction. The second and generally adopted method is to alter the composition. This, while more expensive, has the advantage that it can be applied to heavy plate as well as to sheet glass. At the same time it has the possible disadvantage that it yields a material which is somewhat sensitive to the shortest wave-length solar rays.

In general the special glasses drop in ultraviolet transmission during use, *i.e.*, they become "solarized." It is this question of solarization which has caused more confusion in the minds of the public than anything else, because someone started the rumor that the longer the glass was used the worse it became until finally it was no better than ordinary glass. That rumor had absolutely no foundation for it was based on the idea that since the glass had lost a certain amount of its transmission during one month it would lose twelve times that amount during the year. Actually, the rate of solarization decreases rapidly with the time of exposure so that although the drop in transmission during the first day may seem alarming, it is much less during the second, and so on. When exposed to bright sunlight the glass suffers practically no change in transmission due to solarization after a week or two.

The discovery that solarized "ultraviolet transmission" glass was capable of emitting radiant energy was accompanied by a second discovery that the transmission of the glass was improving at the same time. The original transmission could be restored by heating the glass to a temperature of 300 degrees C. which caused the luminescence to be stronger and of shorter duration. These facts may be considered as evidence in support of the view that solarization is not a destructive process, but is merely a photochemical change in which energy from the sunlight is stored. Considering it from this viewpoint it is to be expected that the extent of solarization should depend on such factors as the intensity and kinds of ultraviolet radiation and that the reaction might be reversed in direction not only by the application of heat but also possibly by exposure to some other kinds of radiation. Just what radiations, if any, would be effective in restoring the transmission were not indicated by any of the findings concerning the luminescence. This question has been answered in part by an interesting piece of research recently carried out in England.[2] Before discussing this, however, it may be well to consider the laboratory methods of studying solarization.

The apparatus used for determining the percentage transmission for radiation of different wave-lengths is commonly set up as follows: Radiation from a quartz mercury arc lamp is passed through a monochromator into a photoelectric cell or thermopile. The intensity of the practically monochromatic ray is measured with a sample of the glass held in its path. The ratio of this to the intensity without the sample of glass is the transmission for the ray which has been selected. These measurements are repeated for a sufficient number of rays to permit the drawing of a curve of percent transmission ver-

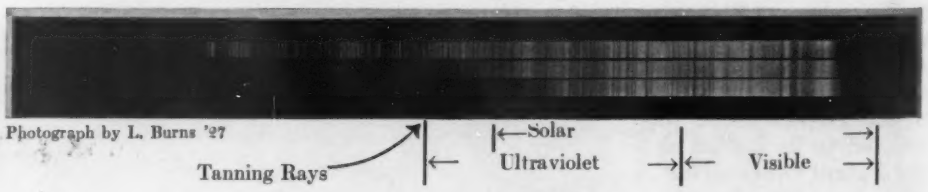


FIG. 2. SPECTROGRAMS OF MAGNETITE ARC RADIATION

Top: radiation unfiltered. Middle: radiation through special window glass. Bottom: radiation through common window glass. Note that the special glass transmits all of the ultraviolet rays which are present in sunlight.

[1] Shrum, Patten and Smith, Trans. Roy. Soc. Canada, 22, p. 433; 1928.

[2] Wood and Leathwood, Nature, London, 124, p. 441; 1929.

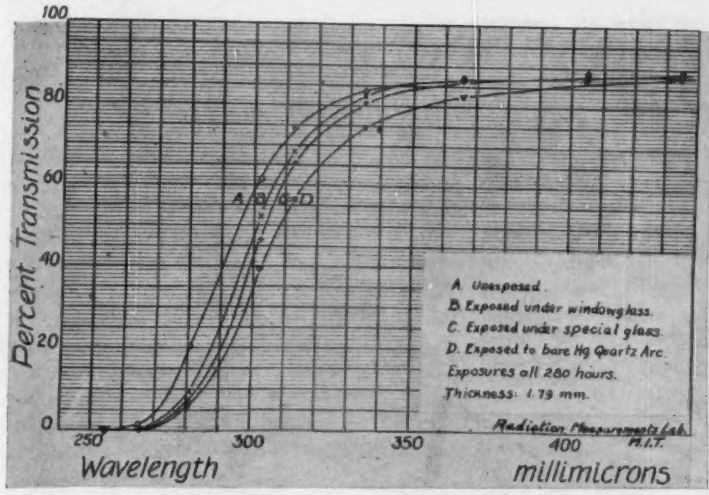


FIG. 3. HOW SOLARIZATION AFFECTS TRANSMISSION OF SPECIAL GLASS

Spectral transmission curves of special glass before and after artificial solarization by ultraviolet radiation filtered by (B) common window glass, (C) special window glass and (D) fused quartz.

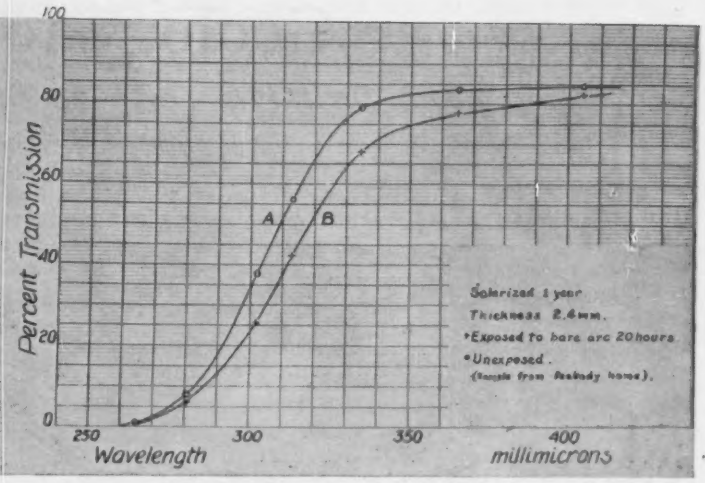


FIG. 4. EFFECTS OF NATURAL AND BARE ARC SOLARIZATION COMPARED

Spectral transmission curves of special window glass after solarization (A) by sunshine and (B) by bare quartz mercury arc radiation.

sus wave-length. After such a curve has been obtained the glass is exposed to a powerful source of ultraviolet radiation until no further change in transmission occurs. Following this process, which usually requires several hours, the transmission measurements are repeated so that the decrease in efficiency at each wave-length can be computed. When the second series of measurements cannot be made immediately after the exposure, the glass is kept cold and in the dark.

Until a little over a year ago bare quartz mercury arc lamps were generally employed as sources for artificial solarization. It was then shown,[1] however, that the action of the short wave-length radiations of the arc caused the photochemical change in the glass to proceed further than it would have if the sun had been used as a source. In other words, the tests were always too severe. In fact the decrease in transmission at some wave-lengths was two or three times as great as it would have been had the glass been solarized naturally. It was also shown that by filtering out the short wave-length radiations by means of a sheet of glass of suitable composition and thickness so as to make the quality of the radiation similar to that of sunlight, the depreciation was comparable with that which is known to take place in normal use. That solarization by the bare arc method is not a fair test is evident from the curves reproduced in Fig. 4. The upper curve shows the spectral transmission of a window which had been solarized naturally while the lower shows how the transmission of that same glass was decreased through exposure to a bare quartz mercury arc.

The researches of the English investigators mentioned above showed that glass which had been oversolarized by exposure to a bare quartz mercury arc could be rejuvenated to a certain extent by exposing it to direct sunlight. For example, one specimen dropped from 59 to 35 per cent transmission at the wave-length 300 millimicrons when exposed to the quartz mercury arc and then increased in transmission to 47 per cent after five days exposure to sunlight. Here, surely, is strong evidence in support of the idea that solarization is a photochemical reaction which can be driven in either direction depending on the quality of the active radiation. To study the matter further two specimens each of two different compositions were solarized on a ship which travelled to Madeira and back. Of these, one of each composition was new and the others were completely solarized by a quartz mercury arc before the voyage. The following table shows that each pair of specimens having identical composition finished the voyage with equal transmissions.

	New Glasses			*Artificially Solarized Glasses*	
	Original (per cent)	*End of Voyage (per cent)*		*Beginning of Voyage (per cent)*	*End of Voyage (per cent)*
A.	*56*	*43*	*A.*	*29½*	*43*
B.	*34½*	*29½*	*B.*	*24*	*29½*

These tests appear to prove conclusively that at least some of the special glasses normally depreciate to a very limited extent, for otherwise after oversolarization by a bare arc they would not return to the normal solarized condition. This is perhaps our greatest assurance that ultraviolet transmission glass is permanent and therefore not a luxury. The situation is therefore quite different from that imagined by the misguided public. There is no reason why every house, apartment, office, factory and hospital should not have at least a few rooms glazed with one of these materials which scientific tests have shown to be satisfactory. In fact, it has often been suggested that busses, street cars, trains and other closed vehicles should be similarly glazed in order that passengers could receive the benefits of full sunlight while travelling. There is a difference of opinion concerning the advantages of glazing north windows. Whether or not sufficient radiation of therapeutic value would normally enter from the north it is certain that a very considerable amount could be obtained, for skyshine is very rich in these rays.

As was suggested nearly a year ago, houses in order to take advantage of the health-giving properties of sunshine should be built upside down.[2] The rooms which are occupied the greatest number of hours during the daytime should be on the top floor and equipped with skylights glazed with some of the special ultraviolet transmitting glasses. If this type of architecture were adopted the residents would undoubtedly be freer from colds and in much better general health than they are today. Had the special glasses proved to be of practical value for only a short time these suggestions would be ridiculous. But now that we know that they are permanent there is no reason why we should not modify our modes of living so as to reap the greatest possible benefits of something which is not only of very great importance but is as free as air and water.

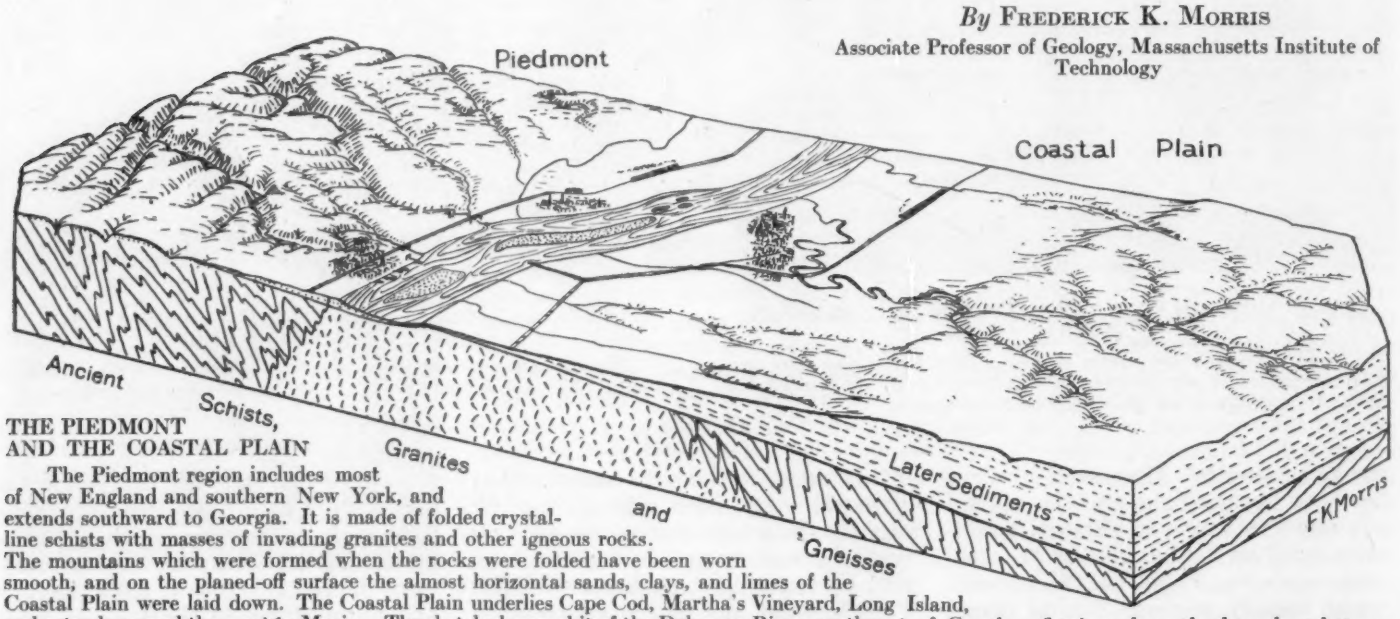
[1] Stockbarger, Dingee and Burns, Modern Hospital, 31, p. 144; 1928.

[2] Stockbarger, Proc. Nat. Housing Asoc., 10, p. 111; 1929.

Geology for Engineers

Things about the earth which an engineer should know, and matters that he should leave to the geologist

By FREDERICK K. MORRIS
Associate Professor of Geology, Massachusetts Institute of Technology



THE PIEDMONT AND THE COASTAL PLAIN

The Piedmont region includes most of New England and southern New York, and extends southward to Georgia. It is made of folded crystalline schists with masses of invading granites and other igneous rocks. The mountains which were formed when the rocks were folded have been worn smooth, and on the planed-off surface the almost horizontal sands, clays, and limes of the Coastal Plain were laid down. The Coastal Plain underlies Cape Cod, Martha's Vineyard, Long Island, and extends around the coast to Mexico. The sketch shows a bit of the Delaware River, southwest of Camden, flowing along the boundary between the Piedmont and the Coastal Plain. In the Piedmont, note the deeply incised valleys with their angular tributaries, which are developed parallel to the axes of the folds. In strong contrast to this drainage pattern are the simple streams of the Coastal Plain, flowing down the torn edges of the soft, thick beds of sand and clay. The block is about 17 miles long and extends northwest-southeast.

MUCH has been written and said about the services which Geology renders to engineering, and part of this propaganda is convincing. No one doubts that the geologist renders able service in predicting buried channels under drift-filled valleys, in searching out joints, shatterzones and faults in rocks, and judging of their behavior in tunnels and in foundations for dams, bridge-piers, or buildings. The geologist warns of rockslides in deep excavations, he discovers sink holes in limestone through which water may escape from a reservoir, or he may find almost equally pervious stream gravels under a lava flow that filled an ancient valley. He predicts the probable behavior of landslide material if a dam abuts against it, he reports the kinds of rock present along the route of a tunnel, estimating their amounts; and warns of permeability, priability, systems of joints, and faults.

He examines the sites of quarries, studying the rock in the field and with the microscope, and collaborates with the engineer in the testing laboratory to judge the value of a given quarry-site for aggregate or building stone, or for the making of lime or cement. He is a careful student of ground waters, and reports upon drainage for highways — and how much waste he could eliminate by this item alone, if he were only consulted. He guides exploration with drill-rig and with geophysical instruments, and critically interprets the results of drilling. Have I offered a fairly formidable list? I have specific cases in mind for every item, and I give you my word, the list of genuine services which a good geologist can render is far longer; and most of my colleagues will blame me justly for many omissions.

Now comes the very practical question: how much of this geology should an engineer know? What should we teach him? It seems clear to me that only a good geologist can do most of the things here listed; and the only way that I know of to make a good geologist, is to select an able man with a bent for geology, train him adequately, and let him practice diligently at his profession, both in pure research and in the application to engineering problems. The formula for making a good engineer is, I think, a similar one; save that we select as raw material, a fellow who has a talent for engineering, and whom we train adequately for that field.

Frankly, I do not see any way to so train the engineer that he can solve the geological problems that arise in engineering practice, any more than we could train the geologist to do the engineer's work. But an engineer ought to know enough about rocks, rock structures, and soils to solve the everyday problems that arise, without calling in a geologist, just as he should know enough about the physiology of digestion to eat the right foods without daily consultation with a dietitian.

Professor Ries, in the *Engineering Journal*,* tells of an engineer who pronounced the rock under a prospective excavation to be limestone. The contractor's bids were based upon the estimated cost of excavation in limestone. Later, the contractor claimed that the rock was shale and that a higher price must be allowed for the work. The dispute assumed serious proportions, for the shale tended to break down and flow into the excavation, and so required timbering, while limestone would have stood solidly. When a geologist was called in he at once identified the rock as shale and the rueful engineer admitted that he had had geology at college, but had paid little attention to it during undergraduate days or after graduation. The engineer and not the geologist should have correctly identified this material. Men who plan excavations should know shale when they see it, and should know what kinds of behavior to expect of shales. The moral of this story, typical of hundreds like it, is that the geological training given to the engineer ought to put him safely beyond the fear of errors in judging the common rocks.

All engineers have read of the St. Francis Dam and of the Moffat Tunnel — and I do not intend to write of them here. However, I believe that the lesson

*Vol. XII, January 1929, pp. 3–7.

they teach is different from that of the "shale" or "limestone" tale. They warn us that the engineer should recognize a problem that calls for a geologist's advice and should insist upon having a competent geologist associated with him in the work.

Not long ago several students urged that it is quite proper to learn and forget again; for then, when we need the lost knowledge, we can always recover it by reviewing. I submit that this is indeed true to a very limited extent, but while some items and even some subjects can be "brushed up" with little difficulty, others cannot be brought back to usable condition. Thus, my students in geological surveying always forget how to use the Beaman stadia arc; but ten minutes with the alidade in the field brings back their knowledge in full brightness. Many formulae in mathematics can be recaptured, after a little angling, and a date in history is as easily recovered as a truant goldfish which has leaped from the bowl into the bathtub. But there are other kinds of knowledge which, when forgotten, are lost like gasoline from a leaking tank. You cannot recover such knowledge — you must mend the tank and pay for a fresh filling.

Even this is comparatively easy to do with our car, but it doesn't work so easily with our brains. If we do not learn the common rocks and their structures well enough so that memory is assured and confusion improbable, then the time spent in learning them is wasted, and the engineer comes to his work in worse condition than if he were frankly ignorant. Sound knowledge of these plain matters may be had without profound scientific study, but it cannot be had without serious application.

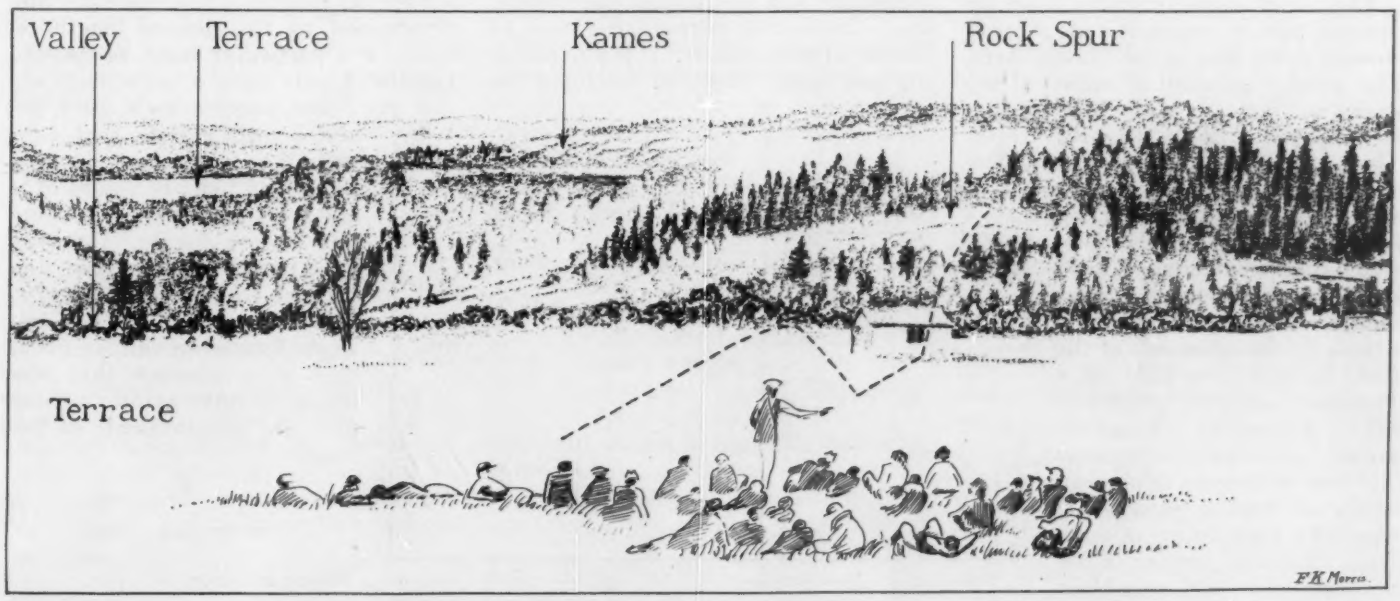
Thus far, we have indicated the need for two quite different categories of geological knowledge which the engineer should possess: first, he should know some things so well that he can attend to them himself without help from anyone else; and second, he should know the kind of problems that are likely to arise in which he needs the help of a professional geologist. The first category includes matters which are not especially difficult or complex but which require some genuine first-hand knowledge and a bit of common sense. The second category includes those problems which the engineer should appreciate, though he does not solve them unaided, and by appreciating them, I mean that the engineer should understand their bearing upon his work, and should coöperate with the geologist, and use intelligently the results which study of the rock, soil and ground water reveals. Otherwise he is between the devil who bids him neglect the geologist whose work he does not understand, and the deep sea which bids him shut his eyes and take blindly what an "expert" tells him.

Workable suggestions — which are really inventions — are made by both engineer and geologist in collaboration. The geologist who studied an important dam site recently emphasized the gravel and sand in the otherwise tight clay of the glacial drift. The engineers solved the problem by extending the danger caused by a bed of pervious upstream side of the earth fill of the dam and thus causing the escaping water to traverse so great a distance through the porous layer that friction would reduce the loss to negligible proportions.

Engineers are notoriously given to traveling and even to exploring. You may be sent to New Hampshire to work on a dam, your next job may be in Georgia, and if your luck exceeds hope, you may even be called to California or to Canada. Yet how many engineers know what conditions of rock, soil and drainage may be expected in each part of the country? "Time enough to learn that when you go there?" "Can look that up anytime?" It is improbable that you will or can, and meanwhile, wherever you go, you are traveling blind. "If I had only known the way in which those mountains were formed; if I could only have read the meaning of those landscapes." These words greet me when friends come back from every vacation and trip. But what is pleasant and stimulating for the traveler to know is a responsibility for the engineer.

We can divide the country into natural units or regions, each containing rocks of a like structure and history, and where the soils and drainage behave consistently within definable rules. Thus, the Atlantic Coastal Plain

(Continued on page 388)



THE SITE OF A GREAT DAM

Before the Ice Age, the streams carved broad, open valleys in the crystalline rocks of New England. Later, the melting ice dropped masses of drift, blocking the valleys partially or wholly. Behind the dams of drift, or of drift and ice, the impounded water deepened into lakes, which received flat-topped deltas of washed sand and gravel. When normal drainage was resumed, the streams had to flow over drift, deltas or bedrock, wherever the lowest levels chanced to lie. In the foreground we see a delta-terrace on which the geologists are industriously studying; just beyond the little house lies the deep narrow stream-course, whose profile is suggested by the dotted line. Beyond that is one of the spurs of bedrock projecting into the side of the formerly broad valley. The diverted stream was thrown across this spur, and has cut a narrow notch into it. In the middle distance there is another delta-terrace made of gravels which were washed into the ancient lake. The kames are hillocks of coarse gravel washed by streams of melting water within the ice margin. A large dam for power will be built upon the rock-spur, against the foreground-terrace.

Graphical Solution of Engineering Problems

By the use of alignment charts, much time can be saved in mathematical computations

By RAYMOND D. DOUGLASS '24

Instructor in Mathematics,
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VARIOUS methods ordinarily employed for solution of mathematical problems are well known to all familiar with arithmetic, algebra and geometry. There is, however, a method of answering a certain class of questions and representing certain results by a direct appeal to the eye which is extremely simple, very effective, and in some cases superior to every other mode. This method, that of nomographs or alignment charts, involves the drawing of a few lines, straight or curved as the problems demands.

What is a nomograph? A nomograph of a formula is a graph or diagram composed of lines, scaled relatively and placed on a chart in such proportion that the values of the variables are found on a line crossing the scales. The usefulness of a diagrammatic solution of a formula is becoming increasingly recognized, and its value is generally in direct proportion to the resistance of the formula to calculation and to the frequency of its use. It is easy to read a nomograph with precision because of the few lines. It provides a tabulation of all possible values, enables solution to be made irrespective of what quantity in the formula is unknown, and also enables one to observe instantly the effect of a change, either large or small, in any one of the variables.

The use of simple graphic tables for computation is encountered in very ancient times and in the Middle Ages. The graphic solution of spherical triangles was in vogue in the time of Hipparchus, B.C. 161–127. Then, in London about 1628, there was developed and used a "Line of Proportion" in the form of a double scale upon which numbers were indicated by spaces on one side of a straight line and their logarithms on the other side of the line. In 1842 Léon Lalanne, a Parisian engineer, published his "Amorphose Logarithmique," in which he explains the first principles of nomography or the preparation of charts for the solution of problems. The real creator of the nomographic chart was Maurice d'Ocgane of the Ecole Polytechnique, whose first researches appeared in 1891. Since then several books have been written on the subject.

The subject of nomography or alignment charts has received considerable attention during the last few years. Although its value as a time and labor saving device is so evident, it took almost a generation from the time of its inception before the American engineer sought to profit by it. And now the diversity of uses to which charts of this class may be put is astonishing. Open any trade or scientific journal on medicine, radio, textiles, chemical engineering, finance, structural engineering, or allied subjects, and count the number of charts. It may surprise the uninitiated to learn that nomographs are also used in medical research. Charts which indicate the flow of blood, bacteria count, and many others of this sort, are typical. One of the first books devoted exclusively to the application of nomographic charts was published in about 1918 as an aid to the early radio amateurs, giving charts which helped them in the proper construction of sets, and aided in arriving at desired results.

In the textile industry nomographic charts are used to replace complex and cumbersome tables, to convert counts, to determine draft, to control yarn twist, to determine weight per yard of fabric, and for many other purposes. Structural and mechanical engineering lend themselves particularly well to the use of these charts. It is also amazing how many chemical reactions can be determined by chart. The convenience of this method is incalculable. Perhaps one of the best known in this subject is the Mean Temperature Difference chart.

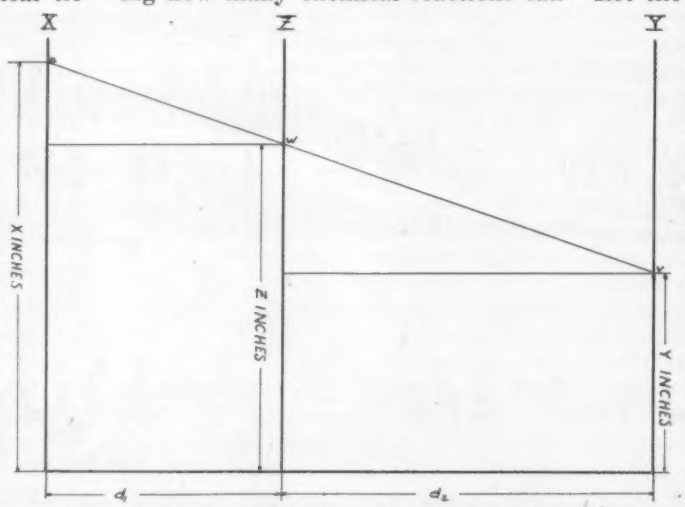

FIG. 1. CONSTRUCTION OF PARALLEL SCALE CHART
This is one of the simpler forms of nomographic charts. A completed parallel scale chart is shown in Fig. 2, Method 4.

Then as an example of the use of nomography in the financial field there are: the annuity formula, the sinking fund formula, and the fundamental bond formula, the latter being represented by this equation,

$$\frac{a}{c}=\frac{\frac{g}{c}(1+i)^n-\frac{g}{c}+i}{(1+i)^n i},$$

for any variable in the formula

Where a = purchase price
c = redemption price
g = nominal dividend rate
i = effective interest rate
n = term of years

Financial experts are becoming much interested in this particular simplified form of solution of their problems, and new charts are being introduced from time to time.

There are two general ways of constructing nomographic charts, either from the standpoint of similar triangles or by a well-known theorem of determinants. One of the most common types of charts in use today is the parallel scale chart, developed by the method of similar triangles as follows: Draw three parallel lines, X, Y and Z (Fig. 1), their distance apart being d_1 and d_2, such that $\frac{d_1}{d_2}=\frac{m_1}{m_2}$ where the m's are the moduli of the scales and are determined by the desired length of scale for a particular range of values. Let the X axis carry a scale $x=f_1(u)$, Y axis carry a scale, $y=f_2(v)$ and Z carry a scale, $z=f_3(w)$, such that a straight line intercepting definite values of u and v will determine the value of w on the Z scale. Drawing lines parallel to the base line through the values of u and v, it is evident that the two triangles formed are similar. From this it is obvious that the distances intercepted on these axes are proportional; as follows:

$$\frac{x-z}{z-y}=\frac{d_1}{d_2}=\frac{m_1}{m_2} \qquad (1)$$

Which reduces to

$m_2x+m_1y=(m_1+m_2)z$; dividing by m_1m_2 we get

$$\frac{x}{m_1}+\frac{y}{m_2}=\frac{m_1+m_2}{m_1m_2}z. \qquad (2)$$

If the X, Y and Z axes respectively carry the scales,

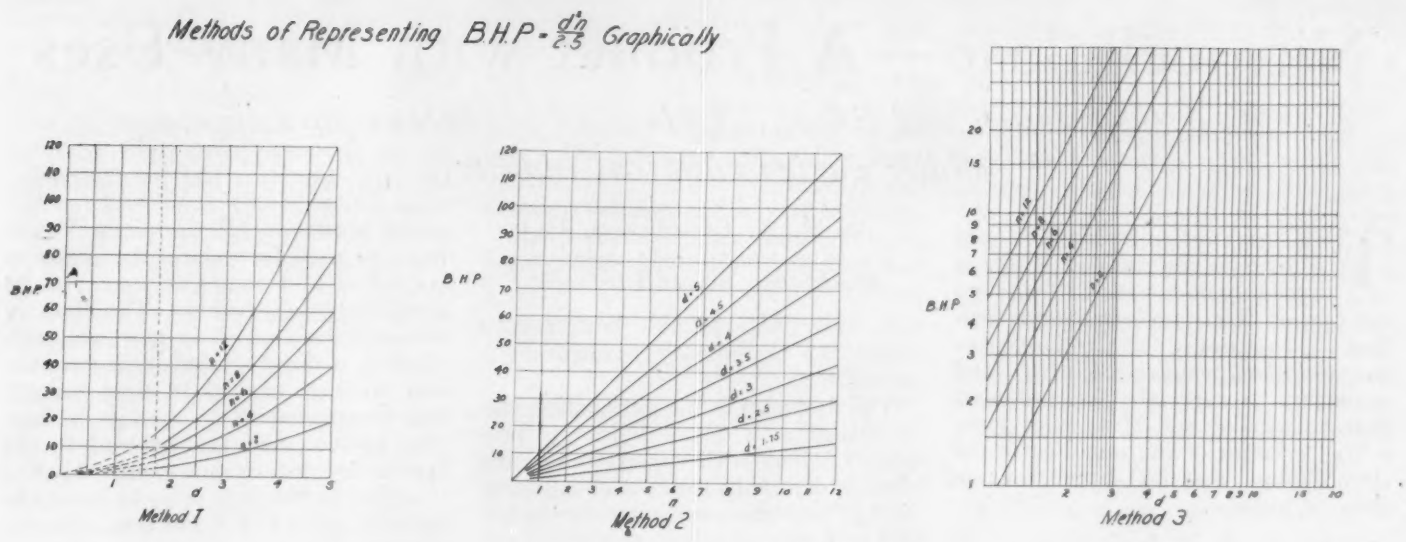

FIG. 2. DIFFERENT METHODS OF SOLVING A SINGLE PROBLEM GRAPHICALLY

The first three methods are ones with which most engineers are familiar. In Methods 4 and 5, alignment charts are used to quickly obtain the answer to $B.H.P. = \frac{d^2n}{2.5}$ for any particular values. As illustrated in Method 4, $d=2.5$, $n=2$, and $B.H.P.=5$. In Method 5, $d=5$, $n=8$, and $B.H.P. =80$, and all values lie along a single straight line.

$$x = m_1 f_1(u)$$
$$y = m_2 f_2(v)$$
$$z = \frac{m_1 m_2}{m_1 + m_2} f_3(w)$$

where x, y, z are distances; then equation No. 2 reduces to

$$f_1(u) + f_2(v) = f_3(w) \qquad (3)$$

It is evident that products and quotients can be reduced to this form by the use of logarithms. In the determination of the values of m_1 and m_2 first consider the equation of the scale $x = m_1 f_1(u)$. Let the range of u be from u_0 to u_n.

Then $x_n = m_1 f_1(u_n)$

$$x_0 = m_1 f_1(u_0)$$

Therefore the length of the scale is

$$x_n - x_0 = m_1[f_1(u_n) - f_1(u_0)]. \qquad (4)$$

The length of scale will be determined by the degree of precision desired. Consequently m_1 is determined from equation No. 4. Similarly the value of m_2 may be determined.

As an illustration of the application of the general formula just developed to the equation $B.H.P. = \frac{d^2n}{2.5}$, where

$B.H.P.$ = brake horse power
n = number of cylinders, range from 2 to 12
d = diameter in inches, range from 1.75 to 5,

the chart shown in figure 2, method 4, is evolved.

$$\text{Log } B.H.P. + \log 2.5 = 2 \log d + \log n. \qquad (5)$$

Let $x = m_1(2 \log d)$
$y = m_2(\log n)$

$$z = \frac{m_1 m_2}{m_1 + m_2} (\log B.H.P. + \log 2.5)$$

$\therefore$ the length of the d scale $= x_n - x_0$
$= 2m_1 (\log 5 - \log 1.75) = 2m_1(0.4560)$
$= 0.9120 m_1$.

Let the scale be 4.56 inches in length then $4.56 = 0.9120 m_1$, and $m_1 = 5$, $\therefore$ the equation is $x = 10 \log d$.

Similarly $y = m_2 \log n$. Length of scale $= y_n - y_0 = m_2 (\log 12 - \log 2) = 0.7782 m_2$. Let the scale be 7.782 inches in length, then $7.782 = 0.7782 m_2$ and $m_2 = 10$, $\therefore$ the equation is $y = 10 \log n$

$$\frac{m_1 m_2}{m_1 + m_2} = \frac{50}{15} = 3.33.$$

Let the distance between the parallel axes X and Y be 10 inches. Then $d_1 + d_2 = 10$ and $\frac{d_1}{d_2} = \frac{m_1}{m_2} = \frac{5}{10} = \frac{1}{2}$ $\therefore d_1 = 3.33$ and $d_2 = 6.67$.

Take two convenient values of n and d and compute the value of $B.H.P.$ from the original equation. These values will determine the points of crossing on the middle scale and they should be so marked. Using the modulus 3.33 and dividing this scale, the above two determined points will give a check on the accuracy of the entire construction.

Another and more general method of

(Continued on page 376)

Nitrocellulose — A Product with Many Uses

Made from cotton seed linters, it plays an important part in many widely varied chemical industries

By H. W. Underwood, Jr.
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THE uses of nitrocellulose are numerous and varied. There is probably no household that does not contain it in one form or another. Rayon, lacquers, celluloid, photographic films, artificial leather, and smokeless powder are all produced from nitrocellulose. This paper gives a brief account of the manufacture of nitrocellulose and its applications in these industries.

Manufacture of Nitrocellulose

In the United States the raw material usually employed is linters from cotton seed. After the mechanical impurities and particles of seed hulls have been removed, the cotton is boiled with dilute sodium hydroxide solution under pressure to remove natural oils. During this boiling, air must be carefully excluded since it would bring about the formation of oxycelluloses, and these would cause trouble in the nitration. The sodium hydroxide is removed by thorough washing with water, and the cotton is then bleached and washed again. When the bales of purified cellulose are received at the nitration plant they are opened by passing them through pickers. The cotton is then carefully dried until the moisture content is reduced to less than one per cent. These steps are necessary to insure the rapid and complete absorption of the nitrating acids by the cellulose. Unopened lumps of cotton or the presence of considerable moisture would cause local overheating, uneven nitration, and low yields.

The modern system of nitration provides for the intimate and immediate mixing of acid and cotton. The apparatus is usually installed in a four-story building. The top floor houses the motors for driving the machinery. The cotton is nitrated, with a mixture of nitric and sulphuric acids, in dipping pots provided with agitators, which are arranged on the third floor. The temperature of dipping and concentration of acids may be varied to give different degrees of nitration. These pots discharge through valved pipes into a centrifugal on the floor below, where the acid is removed down to a content of approximately one pound of acid per pound of nitrocellulose. The centrifugal is discharged through its bottom into bowls on the ground floor. A stream of water, which enters these bowls tangentially, submerges the nitrocellulose and carries it through a trap and flume to the boiling tubs where the preliminary purification is carried out.

The first step in the purification and stabilization of nitrocellulose is prolonged boiling with water (which may contain one-tenth per cent of sulphuric acid). This treatment removes the unstable lower nitrates, sulphates and oxycellulose derivatives. If a low viscosity nitrocellulose is desired the boiling process is carried out at a somewhat higher temperature in pressure digesters. The quality of the final material produced from nitrocellulose is largely dependent upon the degree of purification obtained in the stabilizing process. Nitrocellulose which is to be used in lacquers must contain very small amounts of the less stable by-products.

Courtesy *Industrial and Engineering Chemistry*

PRESSING WATER OUT OF NITROCELLULOSE

Under pressure, the material is dehydrated, and 30 per cent of alcohol added to make possible shipment or storage.

After the completion of the boiling, the nitrocellulose is transferred to beaters where it is reduced to a fine pulp. The purified pulp is washed, and the water content is then reduced to about thirty per cent by wringing in centrifugal machines. In order to remove the last thirty per cent of water, the product is treated with alcohol under pressure. (If the nitrocellulose is to be used for gelatin dynamite or torpedoes and mines it may not be completely dehydrated.) The block of nitrocellulose, which is now wet with alcohol, is disintegrated by a mechanical breaker, packed in steel barrels, and transferred to the storage or shipping rooms. Samples are sent to the laboratory for examination. Alcohol is added to the pyroxylin to bring the content up to thirty per cent. In this condition the material may be shipped by freight or express under the Interstate Commerce Commission classification of "Inflammable Liquid."

By the process of manufacture, the nitrogen content of the nitrocellulose and its properties are varied to meet the requirements of the industry in which it is to be used. If the nitrogen content is high (approximately 13 per cent), it goes into the manufacture of smokeless powder and other explosives. If the nitrogen content is lower than this value, it is used in one of the other industries. The solubility and viscosity of the nitro-cellulose in specific solvents also determine its ultimate use. These factors can be controlled by variation in methods of nitration and subsequent treatment to obtain the desired result.

The use of nitrocellulose in the explosives industry is so well known and generally understood that it will not be discussed here. This article deals with other applications, which are rapidly growing in importance.

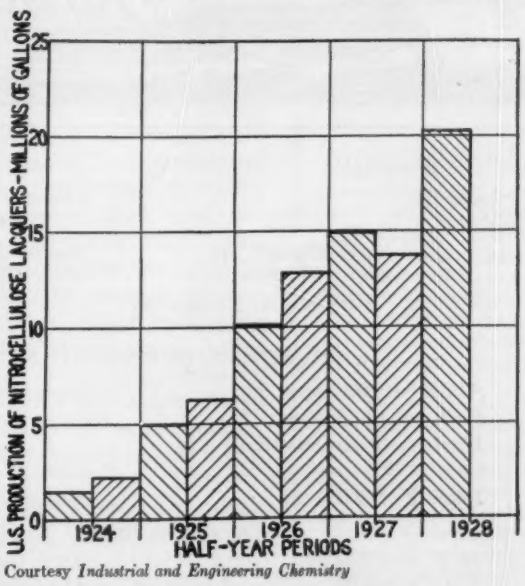
Artificial Silk

Chardonnet, or nitro artificial silk is prepared by forcing an aged, filtered solution of nitrocellulose in alcohol and ether through small glass capillaries, or spinnerets (about one-tenth to two-tenths mm. in diameter) under pressure. The filament from the spinneret, in the dry spinning process, is dried by a current of warm air. The threads are grouped together as they pass through a guide, and are then wound on a bobbin. Since nitrocellulose is inflammable and explosive, the fibers are converted into regenerated cellulose by denitration with a solution of sodium or ammonium or magnesium hydrosulphide. The final product may contain five-hundredths to one-tenth per cent of nitrogen. The fibers are washed several times with pure, soft water, carefully dried in warm air which has been humidified, and bleached. The production of Char-

donnet artificial silk in 1927 was eight and one-half million pounds.

Lacquers

Modern nitrocellulose lacquers are colloidal solutions of pyroxylin (nitrocellulose with less nitrogen than the amount present in the explosive variety), plasticizers, and gums or resins in mixtures of solvents which will yield hard, lustrous and durable films upon evaporation. The recent production of cheap solvents and of pyroxylin which gives solutions of low viscosity and high solid content has made possible the wide use of lacquers, in place of paints and varnishes, for finishing automobiles and furniture and for interior decoration. The old types of nitrocellulose gave solutions of very high viscosity even at concentrations as low as four to six ounces per gallon. At present solutions of extremely low viscosity which contain two pounds of nitrocellulose per gallon can be made by use of pyroxylin which has been heated with water under pressure. A number of good solvents for nitrocellulose, such as ethyl and butyl acetates are now available at low prices.



Courtesy *Industrial and Engineering Chemistry*

NITROCELLULOSE LACQUERS IN THE UNITED STATES

The rapid increase in the production of these finishes since 1923 is due largely to the development of satisfactory solvents and improved methods of making nitrocellulose.

The mixtures of solvents used for lacquers must be carefully chosen and blended so that "blushing," which is caused by the condensation of moisture during evaporation, will be avoided. If the solvents are too volatile, rapid evaporation cools the air around the film below the dew point, and the deposited moisture whitens the film and renders it opaque. Similar effects may be produced by the use of a mixture of solvents which differ considerably in boiling-point. Large quantities of ethyl, butyl, and amyl acetates are used as solvents for lacquers. Ethyl and butyl alcohols aid in the production of a smooth and lustrous film; methyl alcohol is used as a solvent for gums and resins. Some high-grade lacquers contain fusel oil. Ethyl lactate is expensive, but it is growing in favor. Wilson describes the ideal solvent as one which is cheap, miscible in all proportions with other solvents and non-solvents, lighter than water, non-hygroscopic and non-toxic, and which has a boiling-point between 135° and 160° C. In order to reduce costs, lacquer manufacturers dilute pyroxylin solutions with fairly large amounts of cheap non-solvents, such as benzene, toluene, and solvent naphtha.

Nitrocellulose films contract upon drying, and this causes wrinkling and separation from the surfaces to which they are applied. Small amounts of high-boiling liquids or solids known as plasticizers are used in lacquers to make the films more flexible and elastic, and thus prevent contraction. Tricresyl phosphate, butyl tartrate, diethyl phthalate, certain sulphonamides, dibutyl phthalate, triphenyl phosphate, and other analogous compounds have been used as plasticizers.

Practically all lacquers contain gums or resins, which are added to increase the body, durability, and gloss of the film, and to facilitate its adhesion to wood or metals. Large quantities of ester gum are used in lacquers; other important gums and resins are dammar, elemi, gilsonite, pontianak, mastic, shellac, and Congo and Manila copals.

Lacquer enamels are essentially lacquers with which pigments and dyes have been incorporated to give the desired color and body. High strength pigments, such as carbon black, zinc oxide, titanox oxides, toluidine red, Prussian blue, and chromium green, are employed in the preparation of these enamels.

In the automobile industry lacquers have largely replaced baked enamels and slow-drying enamel varnishes. By use of the spraying process, automobiles can be finished in two days or less, whereas painting and varnishing would require the services of a skilled man for a week or longer. The lacquers give a hard, durable finish which resists battery acid, gasoline, alcohol, water and abrasion. Lacquers are now used for finishing steel office furniture, as well as wood furniture and radio cabinets. The cost of interior decoration for hotels, office buildings and apartment houses may be considerably reduced by the use of quick-drying lacquers, which can be applied with a spraying machine. Lacquers are also employed to give a protective and ornamental finish to airplanes, toys, and articles made of steel, brass, silver and nickel.

Celluloid

Celluloid is a compressed solid solution of nitrocellulose in camphor or camphor substitutes. It is prepared by mixing pyroxylin, camphor and alcohol, and adding coloring matter or fillers. The gelatinous mass is transferred to heated adjustable rollers which knead and roll the material into sheets of desired thickness. The sheets are pressed, dried and seasoned; most of the volatile solvent is eliminated in these steps. In some processes sheets of celluloid are pressed into a block by hydraulic pressure. Various substitutes for camphor, such as triphenyl phosphate, have been tried in the manufacture of celluloid, but these substances are not entirely satisfactory.

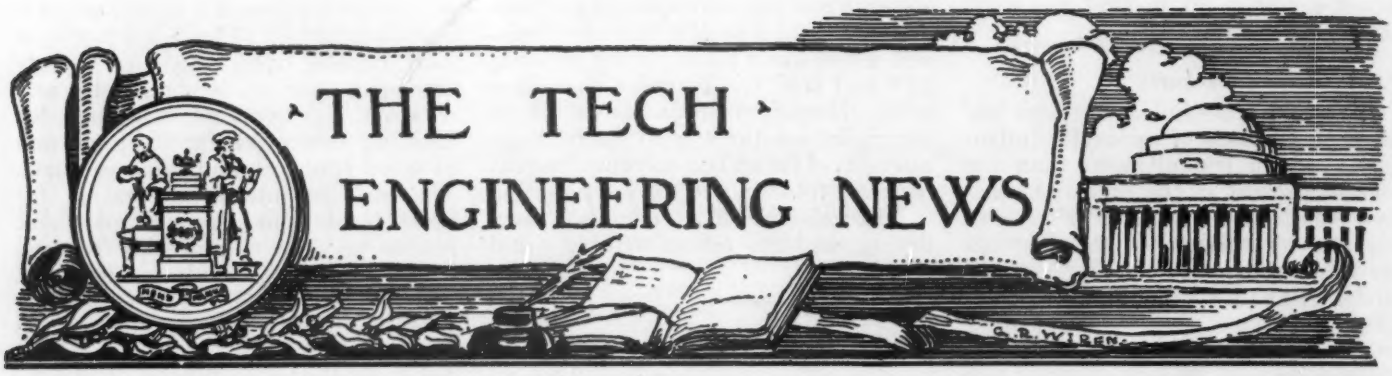
Thin sheets of celluloid are colorless or slightly yellow. The material usually emits a faint odor of camphor. Celluloid has considerable tensile strength, and can be readily cut, turned, drilled, and otherwise worked. It is molded by the application of heat and pressure. Among the numerous articles made from celluloid are handles for cheap cutlery, billiard balls, col-

(*Continued on page 386*)

Courtesy *Industrial and Engineering Chemistry*

CENTRIFUGALS FOR REMOVING ACID

After nitration, the mixed acid is removed in part by centrifugals, or "wringers," and then washed out by water, to increase the stability of the nitrocellulose.



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Editorials

SEEKING THE HEIGHTS

Man, from the earliest ages, has sought to climb the summits, to elevate himself far above the ground. Prehistoric man made his abode in caves, far up on the hillsides rather than down in the valleys, and reveled in his superior location.

With the beginnings of civilization, man expressed his desire for height by building tall structures. The ancient Egyptian erected huge pyramids and temples with tall colonnades that rose far above the ground. The Babylonian built massive towers which reared their great bulk five and six hundred feet into the air and built their altars at the tops. The Chinese also felt the urge and built tall pagodas as did the Hindus. In medieval times, the cathedrals were built as high as the ability of the constructors and the imagination of the designers permitted.

Today, the same urge which caused the caveman and his successors to seek the heights, coupled with the stronger economic pressure due to the high cost of land in congested districts, is causing modern man to erect huge temples of industry which soar to heights undreamed of in former times. Towers and spires are rising higher and even higher, expressive not only of man's desire to get away from the level of the plain, but indicative of the powerful urge of modern economic conditions brought about by the concentration of huge masses of industry and population in small centers.

Where will all this higher and higher construction lead? As more and more people are housed in one building, and as more and more buildings are massed closely together, the problem of transporting the inhabitants daily to and from their tasks becomes increasingly difficult and intricate. Eventually it may become almost impossible.

What will then be the solution? Will humans begin to make their abodes within these huge masses themselves rather than devising further means of daily transportation between their work and their homes? Will these buildings finally become distinct communities with their own theatres, their own churches, schools, and industries? Projects are now under way which, when completed, will house enough people to populate cities of 25,000 to 30,000 souls.

Will these people eventually decide to remain in one location for all of their daily lives? It is an intriguing question. Until now, speed and facility of transportation have made it possible for human beings to make their homes away from the workshop and office. It is becoming increasingly difficult to cope with the problem of transportation, however, and it may well be that either taller and taller buildings cease to be erected within congested areas due to this limitation, or that they will become individual communities.

THE COVER

The cover illustration for the December issue, "Building of a Babylon," is taken from a collection of Martin Lewis' work that the Boston Museum of Fine Arts has recently received. With exceptional realism, the artist portrays the familiar city scene of a deep foundation of a building in progress, while in the background, a completed structure towers above the surroundings.

PROGRESS AND THE ENGINEER

In America today a good many people pride themselves with the thought that there is no such word as "can't." We like to think that everything is possible. That sort of attitude is helpful in many ways and aids in the accomplishment of a good many objects which would not be attained if it did not exist, but there are a good many other things which are clearly impractical of realization at the present time, and which if worked upon simply mean that so much energy is being wasted. As engineers we realize that there is no such thing as a perpetual motion machine, yet there are still a good many searchers after and believers in that will-o'-the-wisp. The engineer, with his scientific training, is equipped to take his place in society and act as a balance wheel, steadying it by pointing out the obvious faults in impractical schemes, while yet being open minded and able to analyze those ideas which may have practical value, see their virtues and aid in their realization.

Engineering is considered by many to be a materialistic sort of work, not on a par with the fine and liberal arts. It is true that we do work with material things, yet it has been largely due to the engineer's work that our modern civilization has been built up and the advances that he has made that have released mankind from much of the drudgery it formerly knew. It has been with this new found time that man has been able to progress in other ways. It is only in modern times that the great masses of the people have had the comforts and the opportunities open in former times only to the rich. We have a right to be proud of the fact that we have chosen engineering for our life work, but we have also certain responsibilities with that profession. It is our duty to honorably discharge them.

CHANGES AND ADDITIONS

With this, the December issue, certain changes have been made in the space devoted to editorial features of THE TECH ENGINEERING NEWS. Since the introduction of the brief biographical sketches of faculty members, which have occupied a considerable portion of the editorial page, we have felt the lack of space to devote to editorial comment. Accordingly, a rearrangement has been made which makes more space available for editorials.

A new feature is also being introduced in the "Among our Authors" section appearing on page 357. We feel that the authors of articles in THE TECH ENGINEERING NEWS are men of high calibre, well qualified to present their information in an authoritative and accurate way. Many of them have achieved high recognition in their respective fields, or have done original work of an unusual nature. It is the purpose of this new section to tell something about the authors, to give our readers a better understanding of the men themselves, and in consequence, a greater appreciation of their articles.

PROFESSOR DAVIS R. DEWEY

Among the prominent men listed with the Institute's faculty is Prof. Davis R. Dewey, Head of the Department of Economics and Statistics. He has been with this department in the neighborhood of forty years, and during that time both the business world and the Institute have felt his influence.

After his graduation from the University of Vermont in 1879, he became the principal of a western high school. This principalship took but two years of his life, however, for after that period he returned to college to study — this time to Johns Hopkins University. From this institution he received the degree of Doctor of Philosophy, in 1886. It was at this time that he first became associated with the Institute, taking the position of Instructor in Economics and Statistics. Six years later he became a professor.

Professor Dewey has always been concerned with industrial problems, as a number of his activities will show, and especially with problems involving labor conditions. In 1893 he was the chairman of the Massachusetts Board to Investigate the Subject of the Unemployed, and several years later a member of the Committee on the Relations between Employer and Employee. During the twelfth United States census in 1902, he was appointed as special expert on wages. Last year, President Coolidge appointed him a member of two boards — one to investigate the dispute of the employees of the Kansas City, Mexico, and Orient Railway, and the other to investigate a dispute among the Western Railway, Order of Railway Conductors, and the Brotherhood of Railway Trainmen.

The outstanding contribution made by Professor to the Institute was his instrumental work in the establishment of Course XV, Engineering Administration, as a regular part of the Institute's course of study. The aim of this new course was "to furnish a broad foundation for ultimate administrative positions in Commerce and Industry by combining with the general engineering training, instruction in business methods, business economics, and business law."

In order to secure the greatest efficiency in production, scientific management is a recognized necessity; Course XV was designed to provide business men grounded in the fundamentals of both business and engineering.

When Professor Dewey first became associated with the Institute, he was the sole instructor in economics. Not only did he teach the subject to students of all courses, but he gave instruction as well in several special courses prescribed for the old course in General Studies, Course IX. Since that time, owing to the increase in the number of students and the growth of an interest in economics, the work of instruction in this department has greatly expanded until now there are fourteen members of the instructing staff, all giving full time.

Professor Dewey is the author of a number of works on economics, among them "Financial History of the United States," "National Problems," "Banking and Credit," a special report on Employees and Wages for the twelfth census, as well as several chapters of the Commonwealth History of Massachusetts. In 1911, he was the director of the economics section of the educational service of the Department of Labor, and has been since 1911 the Managing Editor of the *American Economic Review*.

He is a member of Phi Beta Kappa, a fellow of the American Academy of Arts and Sciences and a member of the International Statistical Institute. He was for many years secretary of the American Statistical Association, and in 1909 was president of the American Economic Association.

THE SURVIVAL OF THE FITTEST

Considerable interest is being shown on the part of the undergraduates in the recent "slump" in the airplane industry. Plants have shut down, others have greatly reduced operating schedules, and the cry of "overproduction" is on every hand. Undoubtedly, with the coming of spring, business conditions in aviation will improve, but it seems certain that the period of undue and unwise expansion of the industry is passed.

The condition is somewhat similar to that in which the radio industry found itself some time ago. For a while, there was plenty of business for everyone, and then, in the period of depression, the weaker, less substantial firms were forced out of business while only the strongest survived. Probably another year will find a much smaller number of airplane companies in the United States, but these will be established on a much more sound basis than they are at the present time, and the condition of the industry as a whole will be a far healthier one than it is at present.

ELECTIONS

We are pleased to announce at this time the following elections: P. P. Shelby '32, to the position of Assistant Publicity Manager; C. E. Buchanan '33, G. Cary '33, E. H. Lloyd '33, O. C. Dunbar '33, J. P. Mills '33, J. A. Dorr '33, A. S. Brown '33, K. H. Clark '33, S. L. Brown '33, C. V. Case, Jr. '33, L. S. Person '33, E. L. Hall '33, to the Business Staff; and D. G. Fink '33, E. R. Atkinson '33, H. G. Starck '33, G. P. Bentley '33, R. L. Brown '33, C. M. Chase, Jr. '33, W. B. Huston '33, A. G. Dietz '32, J. R. McCaa '32, R. E. Moore '32, A. F. Rankin '33, to the Editorial Staff.

The Engineering Field

Abstracts from the leading professional and trade journals

Ten Thousand Acres of Flood Land bordering the Trinity River at Dallas, Texas, are being made useful for commerce in a gigantic reclamation project now in progress at that city. This great amount of land, which is subject to overflow during time of flood, is to be made safe by the erection of twenty-eight foot levees on either side of the river.

At a total cost of $6,000,000, twenty-six miles of floodway levees through which the flood waters may flow in safety will have been completed by the end of this season; 10,400,000 cubic yards of earth will go into the construction of these embankments. Dangerous floods of this river in past years, notably in 1908 in which $2,500,000 damage was done, have hitherto prevented commercial expansion into this territory, although the floods have been rare and very short lived. The present floodway is designed to carry a volume of water twice as great as that of the most disastrous flood, which occurred in 1908. Thus, not only is a great amount of land reclaimed, but very adequate protection against future floods provided.

The fill from which the floodway is being constructed is being dug from pits nearby, thus saving considerable in the cost of the project. The work, which was started in July, 1928, is nearing completion, and it is estimated that all the reclaimed land will be ready for development by the first of next year.

Under this plan, the City and County of Dallas will benefit by 6,812 of the 10,000 acres, which at the cost of six million will put the cost at about $880 per acre. Since the reclaimed land borders on the commercial district of Dallas, it is expected that rapid expansion into the territory will take place as soon as the project is completed.

A Street Car with automatic foot control has recently been put into use in an eastern city. It is one-man operated and has a seating capacity of 44 persons with outlets at front and side. The motorman applies power by the ball of his left foot on a control lever or accelerator, and ordinary braking is performed by his right foot, but in emergencies the car may be more quickly brought to a stop by raising the heel of the left foot which rests on an emergency brake heel plate. There are altogether four sets of brakes: the regular air-operated shoe to wheel brakes; the magnetic track brake; the emergency dynamic braking system common to electric motors; and the hand brake.

This latest improvement in street-car transportation is of light weight, its frame being of aluminum alloys, and its four 34-h. p. motors are built for low wheel service, giving wide and easy entrance into the car. Noise is eliminated by non-resonant gears and noise-deadness on the wheels, and a decrease of from 15 to 20 per cent in running time can easily be effected.

Wireless Reception being disturbed by the proximity of forests or heavily wooded areas has been explained by a French physicist, Albert Rodon, as due to the radiation of ultra-violet rays by the vegetation. Experiments showed that the layer of air in the vicinity of forests and particularly in the layers above the tops of trees is a strong electrical conductor. This capacity was attributed to the presence of ultra-violet rays which later were proved by photographic plates to be the emanation of the plants to woods in the process of cell division. This discovery accounts further for the physiological effect of forest air upon diseased respiratory organs, whereby the healing power may be attributed to the presence of the ultra-violet rays.

The Dornier Flying Boat carrying thirty passengers at 110 miles per hour is the largest seaplane type of aircraft ever assembled and flown in the United States. The ship is, of course, small in comparison with the twelve-motored German Dornier plane which has successfully carried one hundred passengers over a hundred miles per hour, but it shows that in this country also there is a trend toward planes of large capacities.

This American ship has four motors mounted in tandem developing a total of 1,700 h. p. and giving a top speed of 135 miles per hour and a cruising speed of 110 miles per hour.

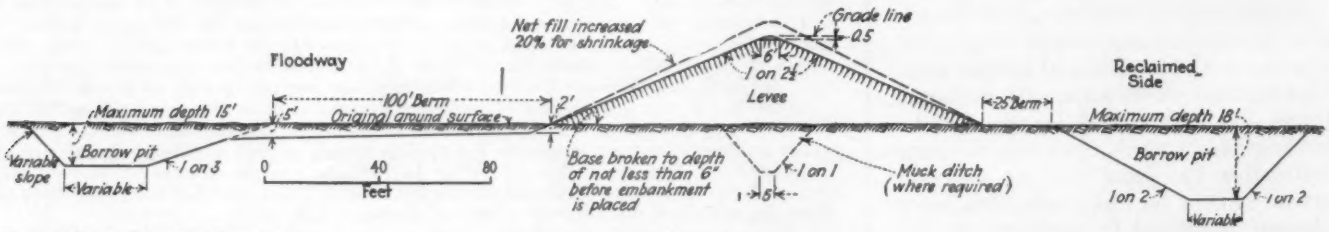
It has been definitely shown that ships such as these of ninety-foot wing spread have a greatly increased factor of safety and are economically advantageous with an increase of payload greater than the increase in weight.

A Railroad Refrigerating Plant in the mid-West provides more than 25,000 refrigerator cars a year with ice, and is recognized as one of the largest raw water ice making units in this country. The new building is 358 feet long, 80 feet wide, and 56 feet high, with a double deck elevated platform, from which 56 refrigerator cars may be iced at one setting, extending 1,000 feet south of the building. Water treatment, engine, brine tanks, and daily storage rooms are located on the first floor, and cars are loaded and stored for immediate use on the second floor.

Ice is formed in some fifteen hundred galvanized cans in 400-pound cakes which take about forty hours to freeze solid. Then the cans are dipped into warm water to loosen the cakes which are automatically taken to storerooms. The present installation has a capacity of producing 165 tons of ice daily, or 825 cakes of 400 pounds each.

"Dry Zero Blanket," a sound-insulating fabric, has been decided by the United States Bureau of Standards to be the most satisfactory material for use in "sound-proofing" airplane cabins. At the request of the Aeronautics branch of the Department of Commerce, the Bureau made exhaustive experiments to determine the best method of making airplane cabins less noisy.

It was found that hair felt, cotton, or



Courtesy *Engineering News-Record*

TYPICAL SECTION OF LEVEES

This diagram shows the construction of the main levees which total 26 miles with a floodway between them of from 2,000 to 3,000 feet.

balsam wood, set between the metal sheathing of the cabin had as much absorption effect as the "dry zero," but that from the weight considerations of the material, the latter was found to be more desirable. The most ideal combination of sound insulators arrived at in the research was a combination of a metal sheave and a quarter-inch fiber board with a layer of "Dry Zero Blanket" between. Thus far experiments have been conducted only upon cabins; no actual tests under flying conditions have yet been made. It has been decided to install a cabin of the above type on a Navy plane, and thus subject it to more rigorous tests.

It is expected that the final report of the Bureau will provide valuable data to the Aeronautics Industry for the solution of one of its most difficult problems, making the airplane comfortable as well as serviceable.

Tread-Like Paddles are used in an unusual method of propulsion of a Mississippi River tug which measures 90 feet in length, has a beam of 18 feet, and a three-foot draft, and is driven by electrical motors which receive current from oil-engine driven generators.

At the side are mounted endless chains to which paddles are pinned and welded, and the whole unit is practically the same as a tractor drive. Two independent chains are used on each side of the tug, each chain having eighteen paddles, making a total of seventy-two paddles. The paddles are of all-metal construction, 34 inches broad, and 14 inches deep. Holes are drilled through the surface to prevent cavitation. Streamlined gratings lowered below the waterline from the front to the back of the wheels protect the driving gear from snags. The tug practically crawls up a river the same way that a caterpillar tractor crawls over the ground.

Tests have proved that with this installation the tug answers surprisingly well to the controls, and can practically be steered without a rudder. Running full speed down a river at about 10 m.p.h., it can be stopped in eighteen seconds, and with 160 h. p. at the wheels, it has ample power to push several loaded barges.

The Atomic-Hydrogen Flame is a new welding tool which possesses certain unique characteristics that make it exceptionally useful.

This flame is a combination of the two foremost agents of intense heat, the oxy-hydrogen flame and the electric arc.

Hydrogen is passed through an electric arc and on to the surfaces to be welded. The intense heat of the arc dissociates the molecules of hydrogen, or forcibly separates the two atoms that form each molecule. This condition is elastic, and the atoms have thus imparted to them a store of chemical energy equivalent to that necessary to separate them. Charged with this energy they again combine into molecules in the cooler zone on the metallic surface to be welded and there release the energy given them by the arc.

Therefore, in the atomic hydrogen flame no combustion takes place until the hydrogen molecules come into contact with the surrounding air, the action, in effect, being a chemical transmission of heat, which is concentrated and intensified by the ultimate combustion of the hydrogen around it. Among its general features it has the property of reducing metal oxides and giving a clean liquid fusion, which leaves a bright, lustrous appearance. Metals that oxidize rapidly at high temperatures are protected by the mantel of molecular hydrogen around the flame center during the process of welding, while the intense heat makes it adaptable to any kind of metal or types of metal welds.

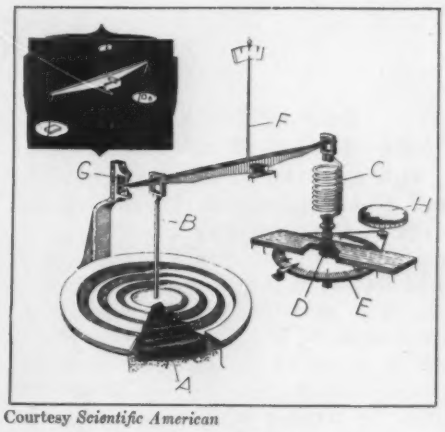
An Altimeter for measuring height very accurately has been perfected for use in airplanes, which operates on the same principle as an aneroid barometer. The atmospheric pressure is weighed on this instrument with the delicacy of a chemist's balance.

Referring to the illustration of the altimeter, A is a vacuum chamber with flexible diaphragm to which is attached a stem B. This stem and the spring

Courtesy *Marine Engineering*

TREAD-LIKE PADDLE WHEELS

The perforations in the paddles prevent cavitation and allow smooth running of the two and one-half inch pitch chains.



Courtesy *Scientific American*

THE ALTIMETER

Movement of the diaphragm is very much less than in ordinary altimeters, thereby reducing "elastic errors of hysteresis."

C are connected to the ends of a beam, and a micrometer screw D actuates a graduated dial E. But the setting knob H rotates the screw D, thus controlling the tension in the spring. When the force of the spring exactly balances the atmospheric pressure on the diaphragm the beam will be midway between the stops at G, and balance will be indicated by the indicator F.

The chief advantages of this instrument are its accuracy and its ability to record changes in altitude near the ground, a duty in which an ordinary altimeter fails miserably. Thus for blind flying close to the ground, and for blind landings in the fog, the instrument is of great use.

Hundreds of Radio Amateurs use the standard frequency service supplied weekly by the Massachusetts Institute of Technology Communications Department experimental radio station WIXV–WIAXV, located on Colonel Green's estate at South Dartmouth, Mass. Operating in conjunction with the American Radio Relay League, this station sends a characteristic signal "G" on a wavelength or frequency within 1/100 of 1 per cent of the correct value as announced, thus maintaining a steadiness which is unrivaled in the field. Radio amateurs use these broadcasts as a check upon their instruments, receivers, transmitters, and wavemeters, and are thus assured that they are operating their equipment within the legal wavelength band assigned them by the government. The degree of accuracy of this steady frequency signal is so high that many amateurs cannot adjust their apparatus to it exactly, but they are still able to obtain an accuracy sufficiently high for their purposes.

Departmental Notes

DEPARTMENT OF FUEL AND GAS ENGINEERING

This fall, the Department of Fuel and Gas Engineering broadened the scope of the field work available to its students by the establishment of a field station at the plant of the Rochester Gas and Electric Company at Rochester, N. Y. The Rochester plant, which is one of the most modern and progressive in the country, offers facilities for studies which are not to be found elsewhere. Its gas-making equipment includes coke ovens, water gas generators and gas producers. The gas purification equipment located there makes possible studies on liquid or dry purification, ammonia recovery and sulphate manufacture, light oil recovery and refining, and phenol disposal. Another important feature of this plant is the dry quencher for cooling the hot coke from the coke ovens. The dry quenching equipment at Rochester, which is the only installation in this country, replaces the water sprays which were formerly used for cooling and permits the recovery of the sensible heat of the coke.

The new Rochester station is now a required part of the course in Fuel and Gas Engineering. Together with the stations previously established it permits actual first hand studies of almost the entire field of fuel processing and utilization.

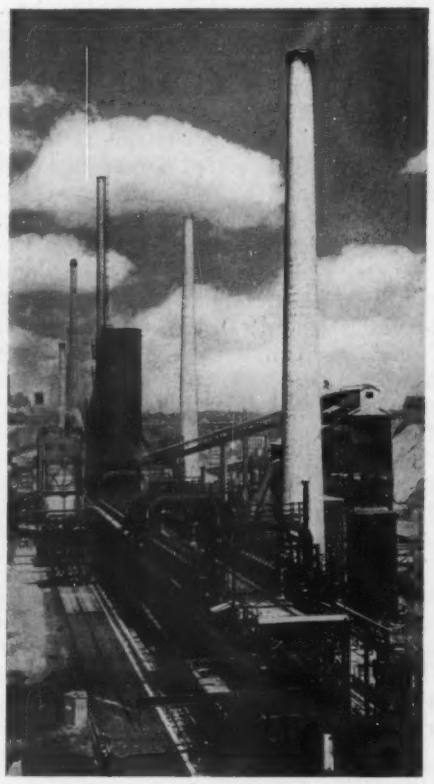
The demand for men having training in Fuel Engineering continues to increase. There are many more positions available than there are men to fill them and the salaries offered are gratifying.

The department is carrying on considerable important research at the present time. An extensive investigation of the cracking of petroleum oils is under way in the Fuel and Gas Engineering laboratory located in Building 35. Equipment has been set up which may be operated continuously at pressures of over 3000 lbs. per square inch and at temperatures of over 1000 degrees F.

A study of gaseous reactions is going on in Room 2–036. Apparatus has been developed for bringing gas mixtures up to reacting temperatures by adiabatic compression, and for following accurately the rapid pressure change resulting from the reaction. The results obtained will be of value in the design of automotive engines.

A problem which is of particular importance to large cities is that of the elimination of carbon monoxide and noxious vapors from the exhausts of automobile engines. The department has been working on this problem for some months and has almost completed equipment which it is hoped will eliminate this nuisance.

Other problems upon which research is in progress include studies of combustion and radiation of pulverized coal flames, radiation from luminous and non-luminous gas flames, synthesis of liquid hydrocarbons from carbon monoxide and hydrogen, manufacture of lubricants, and measurement of large gas volumes.



BATTERY OF KOPPERS COKE OVENS

These form an important part of the new plant in which a field station of the Fuel and Gas Engineering Department has been established.

T. A. Mangelsdorf '26.

DEPARTMENT OF NAVAL ARCHITECTURE AND MARINE ENGINEERING

For a number of years the depression in American shipping resulted in a small group of students in Course XIII, but recently, owing to the scrapping of obsolete war-time ships and Federal legislation favorable to a merchant marine, the interest in naval architecture and marine engineering has increased. Last June there was no difficulty in placing the men graduated in satisfactory positions, and the demand from the shipping industry for trained men exceeds the supply at the present time.

Lloyd's Scholarship, amounting to $500 per year for three years, awarded to the most promising applicant at the end of the freshman year, has been discontinued, but it is hoped that this action is only temporary. The loss has been compensated, however, by the founding of a new scholarship for the course in Ship Operation by the American Bureau of Shipping in memory of the late Mr. Stevenson Taylor, who was head of that organization. The first award of this scholarship was based on the 1929 examinations, and Mr. Harold Champlain '31 was selected, with the approval of the Shipping Board.

There has been lent by Mr. Henry Morss to the Nautical Museum a model of a Japanese fishing boat, which, however, was somewhat damaged before it came to the Institute. There has been some difficulty in obtaining data about this type of vessel, but enough is now at hand to enable the reconditioning of the model, and it will shortly be on exhibition.

Another addition to the Museum is a model of a Danish wooden "line-of-battle" ship of the seventeenth century. While visiting in Denmark some time ago, President Stratton saw the model and believed it to be a type which should be represented here at the Institute. Accordingly, a reproduction is now being made, and it is expected to be on exhibition after the first of next year.

At the Fisherman's Races at Gloucester in August, Professor George Owen had the opportunity to apply his knowledge and experience in a practical way. He was asked to advise one of the fishermen who was getting his schooner in shape for the annual race. Not only did he outline the procedure of "tuning up" the boat for the competition, but he sailed it, the smallest entry, most of the way during the race, and the schooner came in the winner.

A number of papers by Professor Hovgaard have created interest. One was presented before the World Engineering Congress at Tokio in November on "Deflections and Stress in Pipe Bends," and a paper in the *Journal of Mathematics* goes further with "Tests on High-Pressure Pipe Bends." "The Relation between Armament and Protection in the 10,000-Ton Cruisers and the "*Ersatz-Preussen*" was read before the Institution of Naval Architecture in Rome in September, and several articles on "Reduction in Naval Armaments" were published this summer in *London Engineering*, the *New York Times*, and the *Boston Evening Transcript*.

James R. Jack.

The telephone grows air-minded

THE BELL SYSTEM has made many successful experiments in two-way plane to ground telephone communication. This new development illustrates how it marches a pace ahead of the new civilization. It is now growing faster than ever before.

New telephone buildings are going up this year in 200 cities. Many central offices are changing from manual to dial telephones. A vast program of cable construction is going on.

This is the period of growth, improvement and adventure in the telephone industry. Expenditures this year for new plant and service improvements will total more than five hundred and fifty million dollars—one and one half times the entire cost of the Panama Canal.

BELL SYSTEM

A nation-wide system of inter-connecting telephones

"OUR PIONEERING WORK HAS JUST BEGUN"

Recent Books

This department conducted in co-operation with the faculty

Industrial Explorers. *By* MAURICE HOLLAND. *Harper & Brothers, New York. 1929. 347 pages. Illustrated. Price $3.00.*

A feeling of genuine pride must come over any M. I. T. man who reads Maurice Holland's "Industrial Explorers." The purpose of the book is to acquaint the reader with the American leaders in the fields of research, taking nineteen of the greatest research directors as subjects for short biographical sketches. It is indeed gratifying to find that of the entire number, seven, or thirty-seven per cent of the whole, have attended Technology at some time during their career. Some went through the complete undergraduate course; others received advanced degrees. A number of the men found it necessary to leave school early, for financial reasons, while others remained to spend a portion of their lives as members of the instructing staff.

Among the leaders in this modern search along industrial frontiers are Willis R. Whitney '90, Director of Research Laboratories of the General Electric Company; Frank B. Jewett '03, President of the Bell Telephone Laboratories; Prof. Samuel C. Prescott '94, Head of the Department of Biology and Public Health here at the Institute; Arthur D. Little '85, highly renowned chemical engineer; Hugh K. Moore '97, Chief Chemical Engineer of the Brown Company, manufacturers of paper; W. H. Bassett '91, Technical Superintendent and Metallurgist of the American Brass Company; and William H. Miller '22, Director of Research of the Curtiss Aeroplane and Motor Company.

However, it would hardly be fair to claim all the credit for the advances of the past fifty years on behalf of the Institute. The names of Baekeland, Mees, Sperry and Skinner are a few of the others whose work has gained recognition.

The author uses various methods in presenting his different "heroes" to the reader. In some cases the method of work is stressed, the actual accomplishments and achievements of the men. Other instances place the major emphasis on a particular man's personality, and an effort is made to have the word picture of him seem truly lifelike and real.

In such a series of short sketches, one might expect a great amount of repetition in style or subject matter, but such is not the case. Each industrial explorer is interesting in himself and in his work, and the last chapter is reached with as much eagerness and enthusiasm as was felt when first opening the book.

Addressed in part to "the college student, trembling on the brink of the Outside World and pondering a career," it paints a clear picture of the aims, spirit and methods of modern research. It shows the wonderful opportunities which await, and the rewards which have been gained by the man who can vision the goal of the industrial explorer.

H. S. G., JR.

Men and Machines. *By* STUART CHASE '10. *348 pages, illustrated in black and white. Published by the Macmillan Company, New York, 1929. Price, $2.50.*

Are machines, for all their power, worth the human price that has been paid for them? Certain philosophers hold that machinery is enslaving us. In this book, Stuart Chase, who was for a time an undergraduate of the Institute in the Class of 1910, sets out to discover the extent of our serfdom.

After stating the principal philosophic viewpoints held by those criticising modern machine methods, the author sketches both sides of the question in an impartial way. He tells first of the classes and purposes of machines, after which he traces their development from ancient Egypt to modern times in an exceedingly interesting chapter. Hero of Alexandria, Roger Bacon, and Leonardo da Vinci each hold the center of interest for a time and then James Watt appears as the father of the industrial revolution.

The early effects of this revolution and the later effects of mass production methods upon economic life are clearly shown. The amount of contact that the average man has with machines day in and day out, and their effect on the minds of the workers who manage or use them is then discussed. Finally the manifestly good effects of the machine are balanced with the manifestly bad effects and we realize the futility of blanket judgments for or against the machine.

The three greatest dangers resulting from conditions as they exist in our present Power Age are shown to be the growing complexity of mechanical specialization, the mounting drain upon natural resources, and the new mechanized warfare. These dangers face us today and their importance is well shown by the author.

In conclusion, Mr. Chase draws up his balance sheet, collecting the arguments on both sides and inviting discussion of the problems presented. The book is well worth reading, since the problems brought to view are those which directly concern us all.

R. MCC.

The Universe Around Us. *By* SIR JAMES JEANS, M.A., D.S.C., LL.D., F.R.S. *Illustrated. The Macmillan Company, New York, 340 pages. Price $4.50.*

Sir James Jeans, an authority on the subject of which he writes, has produced a book of scientific accuracy written in language which the layman can comprehend. Man has been present but a short time in the history of the universe, and his civilization as compared with the time since its creation, and the time which will probably elapse before it ultimately runs down, is shorter still; yet as the author shows, he has managed in the few years since he started to explore the sky, to learn something of the causes, the results, and the future tendencies of the universe.

Jeans goes into the past, showing how the ages of the stars and the universe have been estimated, giving as a date some two hundred million million years ago when the universe first came into being. He looks into the future, explaining with the aid of the first and second laws of thermodynamics how the universe is constantly running down, its energy ever seeking lower levels; and as water cannot run up hill, so energy which has once fallen to a lower level can never completely go higher again. Thus a time will come when energy will no longer have any difference of potential; it will all be on the same level, and when that time arrives, the universe will have run down. He shows how today, looking into the depths of space millions of light years, the extra-galactic nebulae can be seen, each containing about enough matter to make some 2,000 million stars, while our own galactic system contains between 30,000 million and 100,000 million. And yet, with all this matter, the mean density of space is very small, being given according to Hubble's estimate as 1.5×10^{-31} times that of water.

In the book the author covers a variety of subjects in an extremely interesting manner, with the use of simple similes which make his ideas clear. It is well worth reading by those who are interested in learning more about our universe.

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Graphical Solution of Engineering Problems

(*Continued from page 365*)

charting an equation is as follows: It is well known that when the three points (x_1, y_1), (x_2, y_2) and (x_3, y_3) are co-linear, the determinant

$$\begin{vmatrix} x_1 & y_1 & 1 \\ x_2 & y_2 & 1 \\ x_3 & y_3 & 1 \end{vmatrix} = 0.$$

Where it is convenient to express the x's and y's in terms of parameters as follows:

$$x_1 = f_1(u) \quad y_1 = \phi_1(u)$$
$$x_2 = f_2(v) \quad y_2 = \phi_2(v)$$
$$x_3 = f_3(w), \; y_3 = \phi_3(w)$$

then the axes and their respective scales are directly determined. In this notation equation No. 5 becomes

$$\begin{vmatrix} -1 & 2\log d & 1 \\ 1 & \log n & 1 \\ 0 & \dfrac{\log B.H.P. + \log 2.5}{2} & 1 \end{vmatrix} = 0.$$

Then the defining equations become

$$x = -1 \quad y_1 = 2\log d$$
$$x_2 = 1 \quad y_2 = \log n$$
$$x_3 = 0 \;\; y_3 = \frac{\log B.H.P. + \log 2.5}{2}$$

For the same range of values used in the previous example the scale for n would be twice as long as that for d. In order to have these scales so arranged that both may be read with equal accuracy, introduce scale moduli $m_1 = 1$ and $m_2 = 2$. The relations

$$\frac{m_1}{m_2} = \frac{d_1}{d_2} \text{ and } m_3 = \frac{m_1 m_2}{m_1 + m_2}$$

also hold in this case. Therefore $d_1 = 3.33$ as before.

The equation $B.H.P. = \dfrac{d^2 n}{2.5}$, given above, is represented graphically in Figure 2, five different methods of charting this equation being shown. Method 1 is the ordinary family of curves method, which requires laborious work to construct, and the interpolations in the reading of which are generally difficult. In this particular equation there is, of course, no such difficulty inasmuch as the values of n are not continuous. Method 2 presents several similar difficulties in obtaining exact readings. In most equations there would be the difficulty of interpolations, the difficulty of accurate readings where the lines converge and the complications that result when the scales are non-uniform. Method 3, using logarithmic paper, though better than Methods 1 and 2, still presents the difficulty of interpolations and the complications resulting from non-uniform scales. Method 4 was considered previously in this article when discussing the general type of nomographic chart. Its simplicity in construction and reading is evident. Method 5 is the type of nomographic chart commonly known as the Z type, where the natural uniform scale is used, in contrast to the logarithmic scale of Method 4.

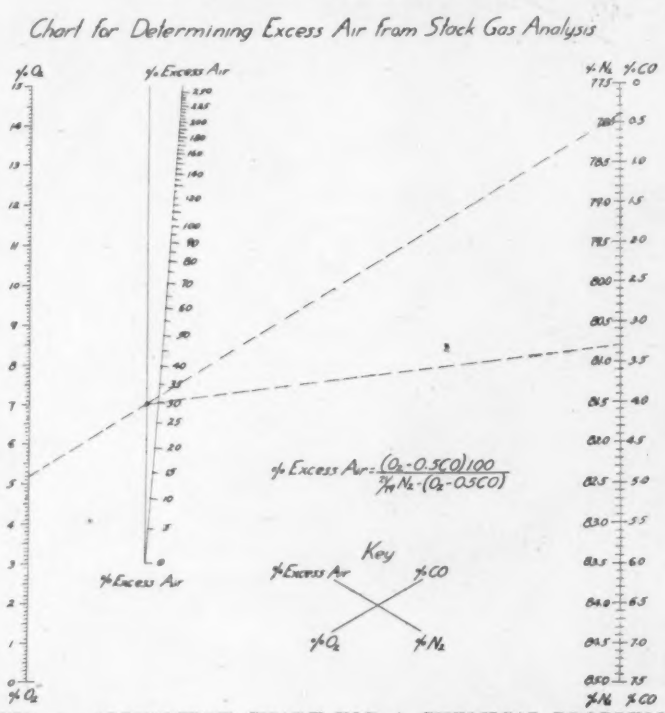

FIG. 3. ALIGNMENT CHART FOR A CHEMICAL PROBLEM

A complicated and much used formula yields readily to graphical solution. This particular analysis was 0.4% CO, 5.2% O_2, 80.8% N_2. A line is drawn connecting the values for O_2 and CO, and then from the intersection of that line with the excess air reference line, a line is drawn to the N_2 scale. The intersection of this line with the excess air scale gives the correct value of 30 per cent.

An example of the application of alignment charts to chemical calculations is shown in Figure 3. In determining the amount of excess air used in furnace combustions, engineers have occasion to use a rather complicated formula which employs the results of an analysis of the stack gases. By making up a chart which makes use of the four variables in the expression, the laborious calculation becomes merely a matter of drawing two lines and reading the result off the chart. Similar methods can be applied to the solution of complicated formulae in other fields of engineering activity.

Despite the fact that there are many industries in which nomographic charts are being increasingly used, there are many industries and many fields in which they could be used to good advantage, but where their introduction has been delayed because of lack of knowledge of their simplicity and a lack of appreciation of the diverse uses to which they can be put. Their adaptability to all of the various fields of engineering and industry and science is unlimited. Among other advantages might be mentioned the following:

1. The extreme simplicity of these charts makes it possible for anyone with little or no skill or training to use them without danger of the errors that extensive computation might involve.

2. The reading from a nomographic chart is on a definite scale and is therefore more accurate than readings from a chart where interpolations and projections on other scales are necessary.

3. Where obtaining data from the ordinary chart involves the use of pen, pencil, slide rule or other aids to com-

(*Continued on page 378*)

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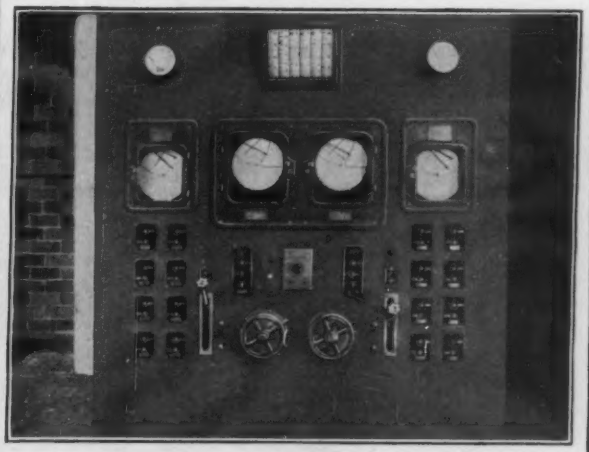

Bailey Meters on a Pulverized Coal Fired Boiler

Graphical Solutions

(*Continued from page 376*)

putation, the nomograph needs only a straight edge.

4. The nomographic chart may be made up to give readings of any desired degree of accuracy over an extensive range of values. This accuracy of readings from nomographic charts is directly proportional to the proper planning and constructing of the charts.

5. Wherever the frequent use of a particular formula is required, the time needed for a single solution of it would often be enough for the construction of one of these charts, and thereafter its use would save many hours.

With the increased realization among engineers of the value of nomographic charts as time savers, the greater will be the demand for them and for a knowledge of their fundamentals of construction.

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Opportunities in Patent Law

(*Continued from page 359*)

after rejection or can contest them, there being opportunity for several appeals. Finally, after due prosecution, assuming he has satisfied the Patent Office that he has made a patentable invention and has properly claimed it, Letters Patent are granted to him, or his assignee, and he has what purports to be the grant for a term of seventeen years of the exclusive right to make, use, and vend the patented invention throughout the United States. But this purported grant is not conclusive.

Letters Patent are only *prima facie* evidence that the Patent Office has deemed the invention therein set forth to be patentable. Whether it is so or not must be decided by a Court of competent jurisdiction. If the owner of a patent has reason to believe that his purported rights of monopoly are being invaded, that his patent is being infringed, he can bring suit against the alleged infringer and cause the latter to be summoned to Court for trial. The defendant then has the opportunity to prove either that he has not in fact infringed or that the Letters Patent are really invalid. The Court then decides the issues and may rule that the patent is indeed of no validity whatever, or may so construe or interpret the claims of the patent as to particularly define and limit the scope of the monopoly conferred by the patent. If the patent is declared invalid, the question of infringement is automatically decided in favor of the alleged infringer; if the Court finds the patent to be valid, then it must also determine whether or not the defendant has actually infringed. Upon a finding of infringement, assuming the case to be tried before an Equity Court, the judge will issue a writ of injunction prohibiting the infringer from further infringing and an order for accounting to the patent owner for past infringements. This may result eventually in an award of all the profits which the infringer has made by virtue of his infringement or an award of damages to compensate the patent owner for the loss he has suffered because of the infringement. If the infringement has been deliberate, wilful or wanton, the Court may, in the exercise of its discretion, increase the award of damages as a punishment to the infringer. This peculiar power of the Courts to increase the damages in a patent infringement suit is the only power conferred upon any Court to impose a punitive penalty for the invasion of a property right.

This somewhat sketchy and rather general outline of patent matters has been given merely to suggest the realm of patent law.

There are so many phases of it that one hardly knows where to begin when attempting to suggest the opportunities therein for the engineer. Someone has said it is far more important for a patent lawyer to be a good engineer rather than a good lawyer, because at least three-fourths of his work will require the application of engineering knowledge. While no one can estimate any such percentage with even "approximate accuracy" it cannot be disputed that by far the greater portion of any work associated with patents certainly is of an engineering nature.

If the engineer does not wish to fully enter the professional practice of patent law, he may find himself of an inventive turn of mind and be lead by force of circumstances into the inventive field. The day of the old-fashioned inventor has passed. We have lately had an example of this in the recent commemorative exercises held in honor of one of America's foremost inventors. Under nearly the same conditions as existed fifty years ago, the honored gentleman reënacted his reduction to practice of an epoch-making invention. Compare the situation and conditions under which Edison struggled a half century ago and those which surround him now. Then, the most meager and crude kind of equipment, and little real knowledge; today, a most thoroughly organized and fully equipped laboratory, and a

(*Continued on page 380*)

William G. Starkweather, M. E., Cornell '92 John B. Starkweather, B. S., M. I. T. '21

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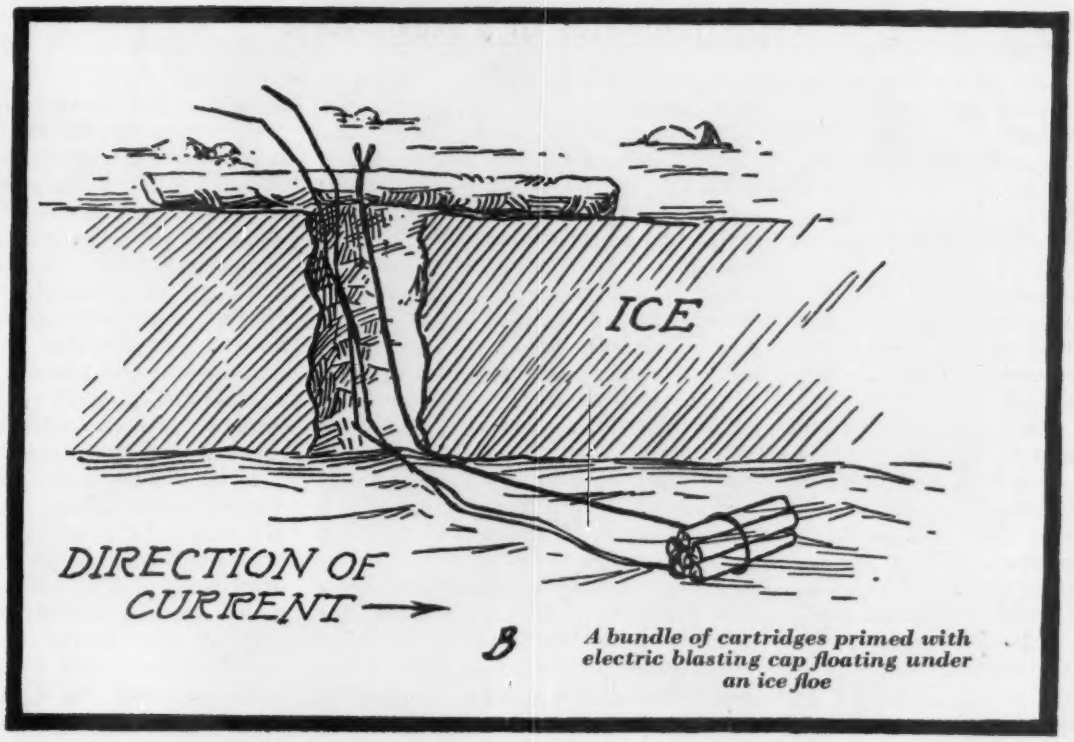

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Opportunities in Patent Law

(*Continued from page 378*)

vast store of information compiled by numerous investigators the world over. And this is not peculiar with the Edison Company, for in practically every line of manufacture is to be found similar conditions. Not only is there provision made for intensive research but many large concerns today have their own patent departments so that any patentable inventions made by their highly skilled investigators may be legally protected. Accordingly, if the young engineer has any creative tendencies and wishes to engage in the field of invention, there are many opportunities awaiting him in the numerous research departments of present day manufactories. Such work is extremely interesting and if one succeeds in producing practical improvements which make the world a little better to live in, there must be supreme satisfaction in that sort of success.

Let us assume, however, that the embryo engineer does wish to practice patent law, what can he do about it? In the main there are two courses to be followed if he can stand the added years of preparation and small income. He may enter the employ of a large business or manufacturing concern in their patent department or he may similarly find employment in a patent law office. There are many so-called law firms who specialize entirely in patent cases. Usually they include trade-mark and copyright matters in their professional work because, for no good reason, a patent lawyer is expected to be versed in trade-mark and copyright law. The salary paid such an apprentice is not large, probably not as large as the young engineer might receive if he were to follow his own particular engineering work, or take a quasi-engineering business position.

While on this subject of income, it may be stated frankly that the rich lawyer is rather the exception than the rule, because the fundamental purpose and efforts of any honest lawyer are not to get rich but to render helpful and worth-while service to his clients and assist the Courts in their administration of justice. It does seem, however, that most patent lawyers who continue in their chosen profession make a very comfortable living, occupy a respected place in the community, and seem thoroughly content with their lot. One thing in particular, which is not to be regarded lightly, is that in the practice of patent law there is no "old age" prohibition. On the contrary, so long as a patent lawyer retains his faculties and can practice his profession, age is really an asset because it makes the mind keener, gives better balance and perspective, and necessarily results in a more profound and ripened judgment. By the same token, the young engineer must appreciate that in the years of his apprenticeship he will find the going a bit hard because of the preferred capacity of those with many years of experience before them.

If the young man enters a patent department of a large firm, or a patent law office, he may start work on the drafting board making patent office drawings. These are the drawings which usually accompany a description of the invention — called the specification — and disclose the best mode in which the inventor has contemplated applying the principles of his invention. Or the young man may be set at work drafting patent applications.

The engineer is particularly fitted by his technical education and training to become a drafter of patent applications.

(*Continued on page 382*)

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Opportunities in Patent Law

(*Continued from page 380*)

He has been taught to find out what the reason is for certain things happening. He has learned to get at the "fundamental facts," the real whys and wherefores. He has been trained to consider the influence and bearing of factors slightly or greatly altered and to theorize on what might be if conditions were different. All this helps in the preparation of an application because it enables the drafter to weigh the invention before him and grasp its inherent value. It enables him to discuss the subject matter with the inventor on a common basis, for by far the greater number of productive inventors today are similarly educated and trained men. Engineering training gives the claim writer the poise and balance necessary for a proper appreciation of the prior art and a fair valuation of the improvements which constitute the invention.

In due time the young apprentice may feel that he is qualified to set himself up as a patent solicitor. The rules of practice of the Office still permit any person who is not an attorney at law, but who is a citizen or resident of the United States, who is of good moral character and of good repute, who has the necessary legal and technical qualifications to enable him to render applicants for patents valuable service, and who is otherwise competent to advise and assist them in the presentation and prosecution of their applications, to be entered upon the register of attorneys at the Patent Office. There have been some attempts made recently to limit this right to register to only members of a legal bar, the underlying and laudable purpose being to put a stop to the practices now being carried on by various patent solicitors whose own interests invariably far exceed those of their innocent clients. If any such change is affected in the requirements, it may prove beneficial to the inventive public, because it seems perfectly logical to conclude that a patent application should be prepared and prosecuted by one trained for and familiar with the forum where the value or scope of the patent is ultimately to be determined.

But there have been, and are today, many first-class solicitors of patents who have never been admitted to any legal bar. Of course, they cannot conduct any patent litigation before the Courts, but they can and do practice successfully before the Patent Office.

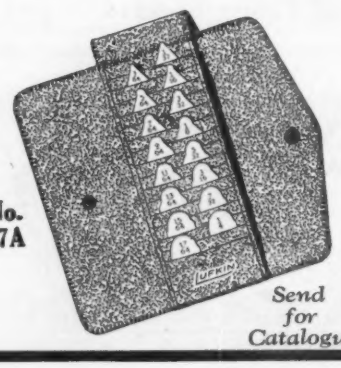
Preferably, however, the young apprentice in the patent law office or in the patent department of a factory will take up the study of law either by way of a correspondence course, a night school or, if he is so fortunate, by attending day school a part of each day. This will probably cover a four-year period at least, and possible five, but in the end he ought to pass some State's examination for the bar and be admitted to practice in the State Courts. Soon after that he becomes eligible to be admitted, without further examination, to the bar of a United States District Court, and thereafter in due course to become a member of the bar of the Circuit Court of Appeals for the circuit in which he resides and a member of the bar of the Supreme Court of the United States. It must be kept in mind that patent law is administered by the Federal Courts, and it is the goal of all young patent lawyers to become members of the bars of these Courts. But admittance to the bar of a State Court is a necessary step which must be taken.

Upon being admitted to practice before the Courts, the young patent lawyer may be said to have established his foundation. The edifice which he thereafter erects is entirely dependent upon himself and such favor of circumstance as may come his way. At first, he had better continue his association with his law firm or patent department and assist older and abler lawyers in the preparation of their cases. Sooner or later he will get his chance to actually try a case, and finally in the course of time he will suddenly discover that he is a practicing patent lawyer. In some unexplainable way, clients will have come to him and he may be able to open his own office or enter into a firm of lawyers as a member thereof.

The other course for a young engineer to follow is through the Patent Office. At frequent intervals, civil service examinations are conducted for applicants to the positions of Junior Patent Examiners. These positions in the office now pay two thousand dollars a year. Advancement beyond the junior grade depends upon individual efficiency, increased usefulness, and the occurrences of vacancies in the higher positions. Of course, the choice of entering the Patent Office as an Examiner necessitates residing in or about Washington. In this city are several law schools whose hours of classes and whose curricula are particularly adapted to employees of the Patent Office who wish to study law in general and patent law in particular. It is quite possible and usual for a young examiner in the Patent Office to complete a law course in one of these Washington schools in three years, and become admitted to bar of the District of Columbia. He can then resign from the Patent Office and enter the office of a patent law firm, or he may try to establish his own office at Washington, doing associate work for attorneys all over the country.

Just which course of procedure is to be preferred is hard to say. Some law firms will only take on young men who have served as examiners in the Patent Office. Others will not employ such. The young man with Patent Office experience is deemed valuable because of his working knowledge of the practice within the Office and his acquaintance with the so-called examiner's viewpoint. This acquaintance, on the other hand, is often felt to be a detriment to the practicing lawyer. because it tends to make him combative rather than

(*Continued on page 384*)



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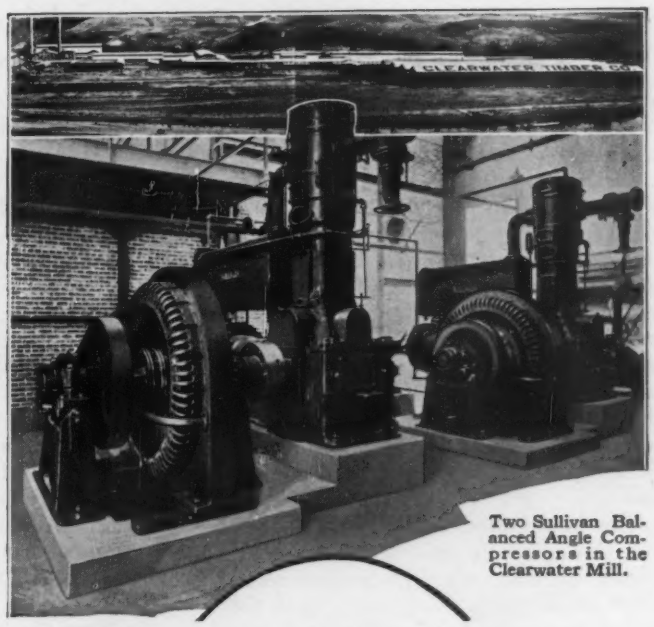

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Opportunities in Patent Law

(*Continued from page 382*)

receptive to new inventions. Of course, an Examiner tries to minimize every invention placed before him and seeks to find anticipations of more or less pertinence. He is always a native of Missouri. If he remains too long in the Office and then leaves for private practice he is very apt to find himself looking askance at a client's invention rather than assuming the proper role of attorney — one who takes his client's place. But this seems to be about the only real objection to pursuing the course through the Patent Office and certainly this criticism is a debatable one.

The two courses outlined thus briefly are those which can be followed by young engineers who "go on their own" after graduation. Both have been followed successfully by many men who are today eminent patent lawyers. There is still another course, the ideal one, but not so easy to follow unless someone else is paying the bills. That course is to go from the engineering school to a full-time day law school and there study law. When the bar examinations have been passed, then to enter a patent law office and begin the task of drafting patent applications or assisting in the prosecution of cases before the Courts. That course is said to be ideal, and yet one of the leading patent lawyers of this country, who wished his son to become associated with him, sent the boy to a university and then to law school. This father, who himself had attended an engineering school before receiving his LL.B. degree, felt that the boy would become a better patent lawyer if he did not attend an engineering or scientific school. As the father put it, "His practice will be before judges who are not technically trained and it will be to the boy's advantage to have the same general background as the judges because he can then more readily appreciate their viewpoint." This reasoning seems no more logical than for a doctor to tell his son, "If you want to become a doctor, don't go to a medical school, because later the persons you are going to practice upon won't know anything about medicine and you will be better able to appreciate their viewpoint."

Even if one intends or hopes to practice patent law only before the Courts, an engineering or technical training is an extremely helpful asset, if indeed it is not truly essential. Today the points upon which patent cases are won or lost are very fine, and as the prior art increases by lapse of time these points will become even nicer. If the patent lawyer is not well trained on the engineering side of his work he is bound to be seriously handicapped.

It seems perfectly conclusive that an engineering education is a vital qualification of a patent lawyer. Consequently any graduate engineer may confidently assume that he has completed the first step he ought to take if he wishes to practice patent law. There are still many more ahead, but none so difficult as that which is behind him. He will find the future work extremely interesting; he will of necessity make contacts and friends with many able and worth-while men. The going may be a bit rough at times, but nevertheless the field of patent law may be deemed a fertile ground of real opportunities.

The World's Largest Building, which will contain 53,000,000 cubic feet, a volume far exceeding the cubic content of any other building in existence, is under construction on the Chicago River in Chicago. Although having only eighteen floors in the main structure, the frontage along the river is 724 feet. The Merchandise Mart, as it is called, will be surmounted by a tower in the central portion of the building containing five extra stores.

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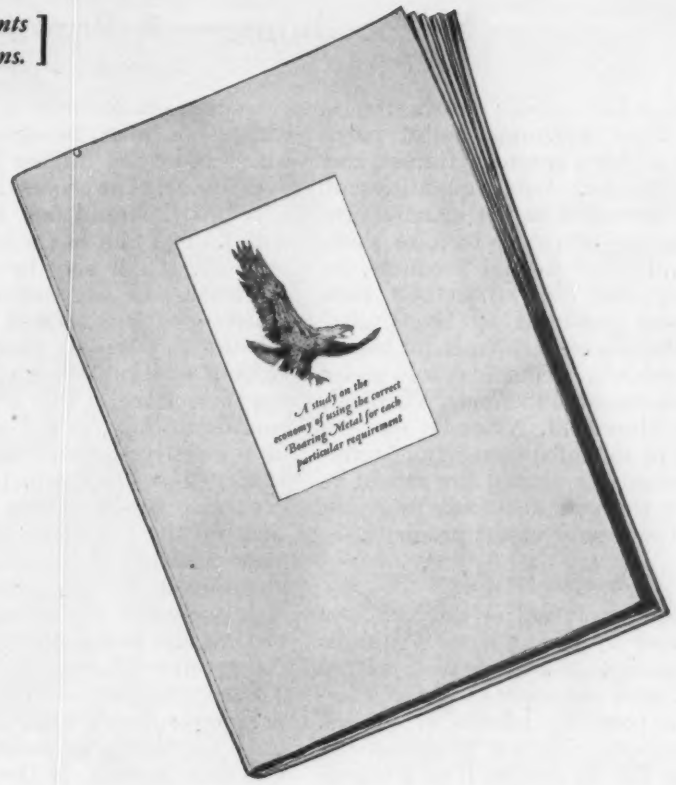

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Nitrocellulose—A Product with Many Uses

(*Continued from page 367*)

lars, piano keys, tooth brushes, shoe eyelets, toys, buttons, combs, parts of toilet articles, spectacle frames, and printing blocks. Large quantities of celluloid are used in the manufacture of imitations of ivory, tortoise shell, agate and other natural products. In 1924 celluloid films 0.0000039 inch thick were produced by the United States Bureau of Standards for use in X-ray research. Celluloid is sold under such names as Fiberloid, Viscoloid, Pyralin, Herculoid, Xylonite, etc. On account of the inflammability of celluloid, precautions against fire should be taken in the manufacturing processes and in the storage of the products.

Photographic Films

A viscous solution of nitrocellulose is prepared by mixing it with suitable solvents, such as acetone and methyl alcohol, and softeners, such as camphor, in tumbling barrels or mixers. The pyroxylin solution is spread out as a thin film by coating it on a traveling surface. In the United States the manufacturers use large, highly polished, nickel-plated wheels, each about four feet across and fifteen feet in diameter, which rotate slowly about the axes so that by the time one rotation is completed the solvents have evaporated sufficiently to set the film, which can then be stripped off the wheel and dried further by passing it over drums. The process is continuous, and two thousand feet rolls are produced. The film has a high polish on both sides, and may be used at once or stored and seasoned until needed.

Before an emulsion is applied, one side of the film is treated with an etching solution which slightly roughens the surface so that it will hold the emulsion firmly. The back of camera film is covered with a non-curling, hardened gelatine which imposes an expansion strain on this side equal to that of the emulsion on the other. Camera or roll film base is about three and one-fourth thousandths of an inch thick, and the thickness of motion picture film is about five and one-half thousandths of an inch.

Since cellulose nitrate is highly inflammable, much work has been done on films that will burn less rapidly. Cellulose acetate is the most promising material, and this is now used as "safety film" under all conditions where proper precautions against fire can not be taken, as in houses or schools. Sixteen millimeter film for amateur cinemaphotography is made of cellulose acetate.

The gases (carbon monoxide and oxides of nitrogen) produced by the combustion of nitrocellulose films are very toxic. Some states have strict regulations about the storage of this material. In Massachusetts the rules issued by the fire marshal state that nitrocellulose films must be kept only in such concrete, non-combustible buildings as shall be approved by him or by the proper authorities in the various cities and towns. In hospitals and other similar institutions the films may be kept in buildings which are not a part of the institution itself. Nitrocellulose films must be stored in metal boxes placed at a substantial distance from any agency that creates or distributes heat. The quantity of films which may be stored in any one place is limited. Smoking near films is strictly forbidden, and all electric switches, etc., must not be located in the room in which the films are kept. Fire extinguishers must be placed in storage rooms.

Artificial Leather

Artificial leather is a term generally applied to any composite material prepared by spreading a coat of pyroxylin upon a base of cloth, felt or paper,

(*Continued on page 388*)

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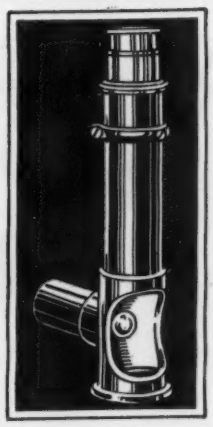
Why Modern Engineering Hinges on Optical Science



INDUSTRY today is a rapidly increasing variable with *mass production to the nth power* as its final limit.

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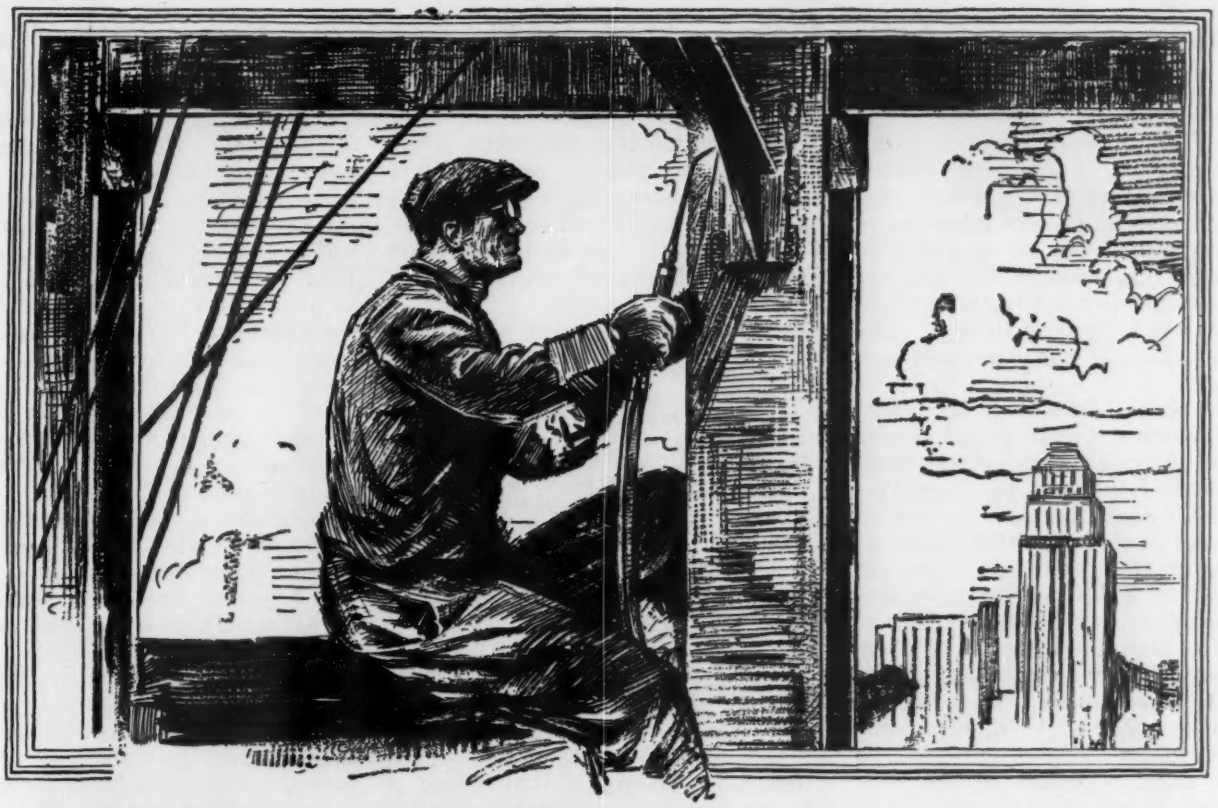

A NEW ERA IN STEEL CONSTRUCTION

Oxy-acetylene welding permits a flexibility of design and construction unknown to any other method of joining metals. Long established in other fields of industry, it is now taking an important place in the fabrication and erection of structural steel.

The oxy-acetylene welded joint is as strong as the members themselves. Tough and ductile, it combines those characteristics which assure a dependable structure fully capable of meeting the severe loads and stresses of modern building. There is the added advantage that construction by the oxy-acetylene process is practically noiseless. Oxy-acetylene cutting, too, is indispensable in this field.

Motion pictures (in either standard 35 mm. width or 16 mm. width) showing the application of these processes in the fabrication and erection of structural steel are available to engineering schools and technical societies without cost.

From time to time the oxy-acetylene industry is in the market for technically trained men. It offers splendid opportunities for advancement.

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One of a series of advertisements featuring College men serving this industry.

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UNION CARBIDE AND CARBON CORPORATION

30 East 42nd Street UCC New York, N. Y.

Nitrocellulose — A Product with Many Uses

(*Continued from page 386*)

and embossed in imitation of grain leather. The manufacture of artificial leather is not a complicated process. The more important steps are: the preparation of the nitrocellulose solution, incorporation of an oil and pigment with this solution, distribution of the mixture upon the fabric or other base material, evaporation of the solvent, and production of an embossed surface.

Cotton cloth, free from imperfections of weave and made from uniform yarn, is generally used as the base. Light weight fabrics, such as sheetings, are usually sized, and heavy weight fabrics are teased to raise the nap. Usually the cloth is dyed to prevent discoloration of the back from becoming apparent if the coating works through. Many solvents and combinations of solvents have been tried, but the formulas are kept secret. Since the industry is highly competitive, relatively few solvents are actually used. Mixtures of amyl acetate or ethyl acetate with benzene or other cheap diluents are important. Oils, such as castor or linseed, are added to make the film flexible, and pigments may be introduced. A number of coats are applied to the base. After all or most of the solvent has been removed from the product, it is embossed in plate or rotary presses so that its appearance will resemble that of grain leather. Imitation Spanish or Morocco leathers are finished by hand.

Selected Literature References

Articles: Schlatter, The Chemistry, Manufacture and Uses of Nitrocellulose, *Chemical and Metallurgical Engineering*, 25, 281 (1921); Partridge, Developments in Nitrocellulose Production, *Industrial and Engineering Chemistry*, 21, 1044 (1929); Artificial Leather and Coated Fabrics, *Chemical and Metallurgical Engineering*, 23, 487 (1920). The fourteenth edition of the Encyclopedia Britannica contains an excellent article on Photography, in which the manufacture of films is described. Books: Foltzer-Woodhouse, Artificial Silk and its Manufacture (1924); Reinthaler-Rowe, Artificial Silk (1929); Wilson, Pyroxylin Enamels and Lacquers (1927); Beckmann, Celluloid (1921); Masselon, Roberts, and Cillard, Celluloid (1912); Marshall, Explosives (1917); Worden, Technology of Cellulose Esters (1921).

An Acid Proof Cement which is affected by no chemical except hydrofluoric acid is now available. Its principal uses are for acid concentrators, Gay Lussac towers, and Glover towers.

Geology for Engineers

(*Continued from page 363*)

differs sharply and consistently from the Piedmont in rocks, structure, drainage, ground water and soils. Each region offers its own problems of water supply, foundations, soils, supplies of building stone, ballast and aggregate. There is scarcely a tunnel of any kind in the entire Coastal Plain, though in the adjoining Piedmont there are railroad bores, subways and water-supply tunnels in abundance. The expectability in all these features may be learned at comparatively little expense of effort and time, provided that we study in an orderly way.

We might have called this little essay a sermon on what an engineer himself ought to know about geology in distinction from what he should leave to the geologist. To have a clear, commonsense knowledge of rocks, joints, ground water, soils and streams in their relation to engineering; to know how to work intelligently with consulting scientists when they are called into the case; and to understand the larger configuration of our country's rock floor — these aims are attainable within the reasonable periods which the engineer can afford for geological studies; and they are well worth attaining.

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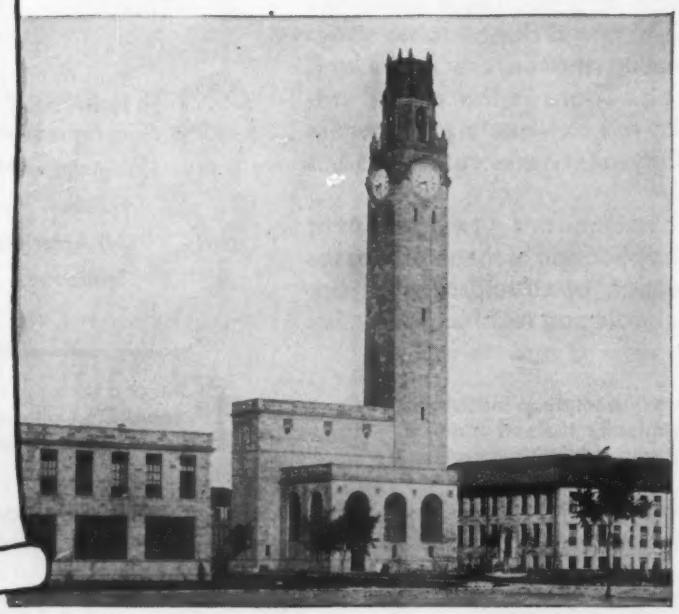

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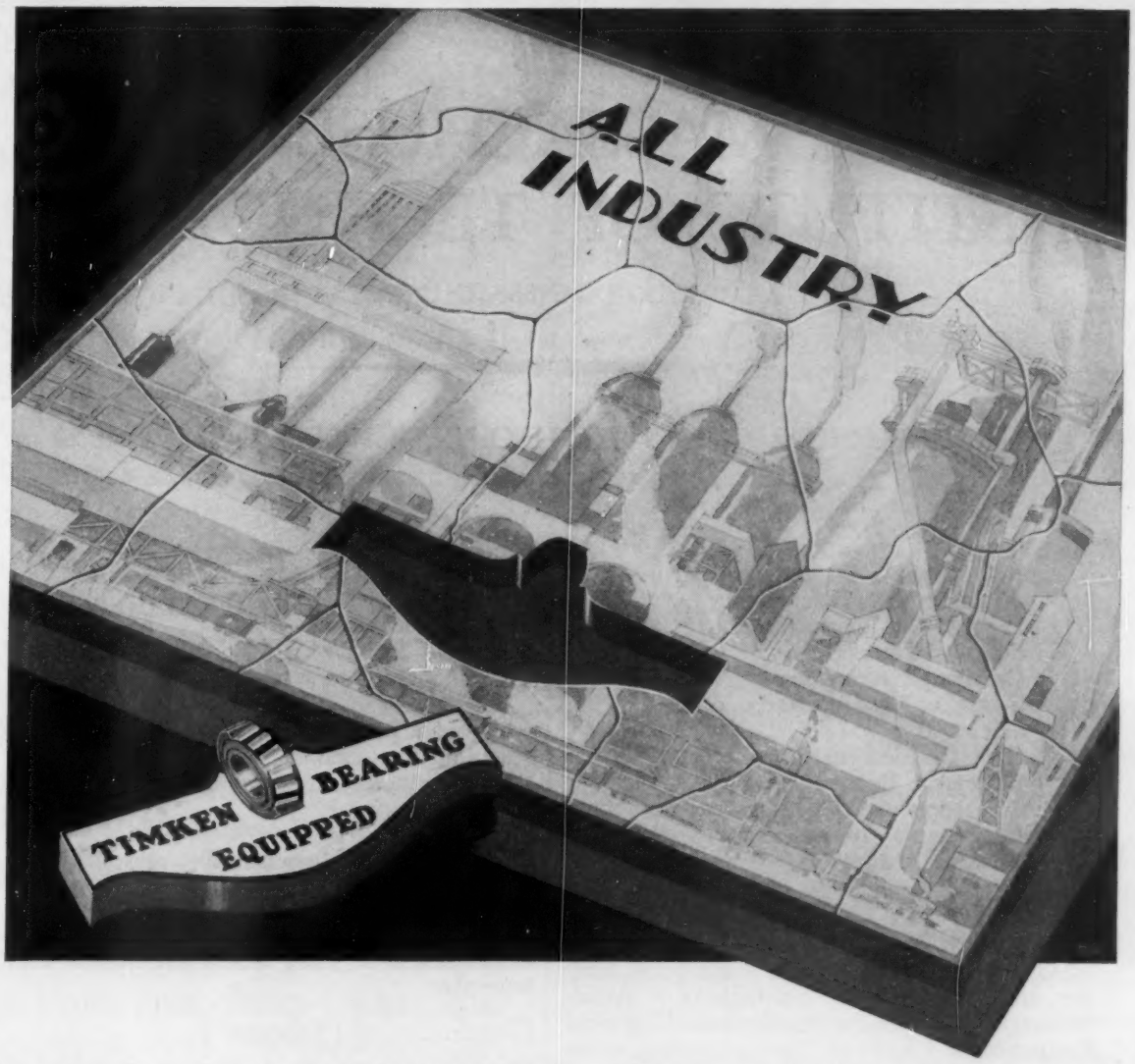

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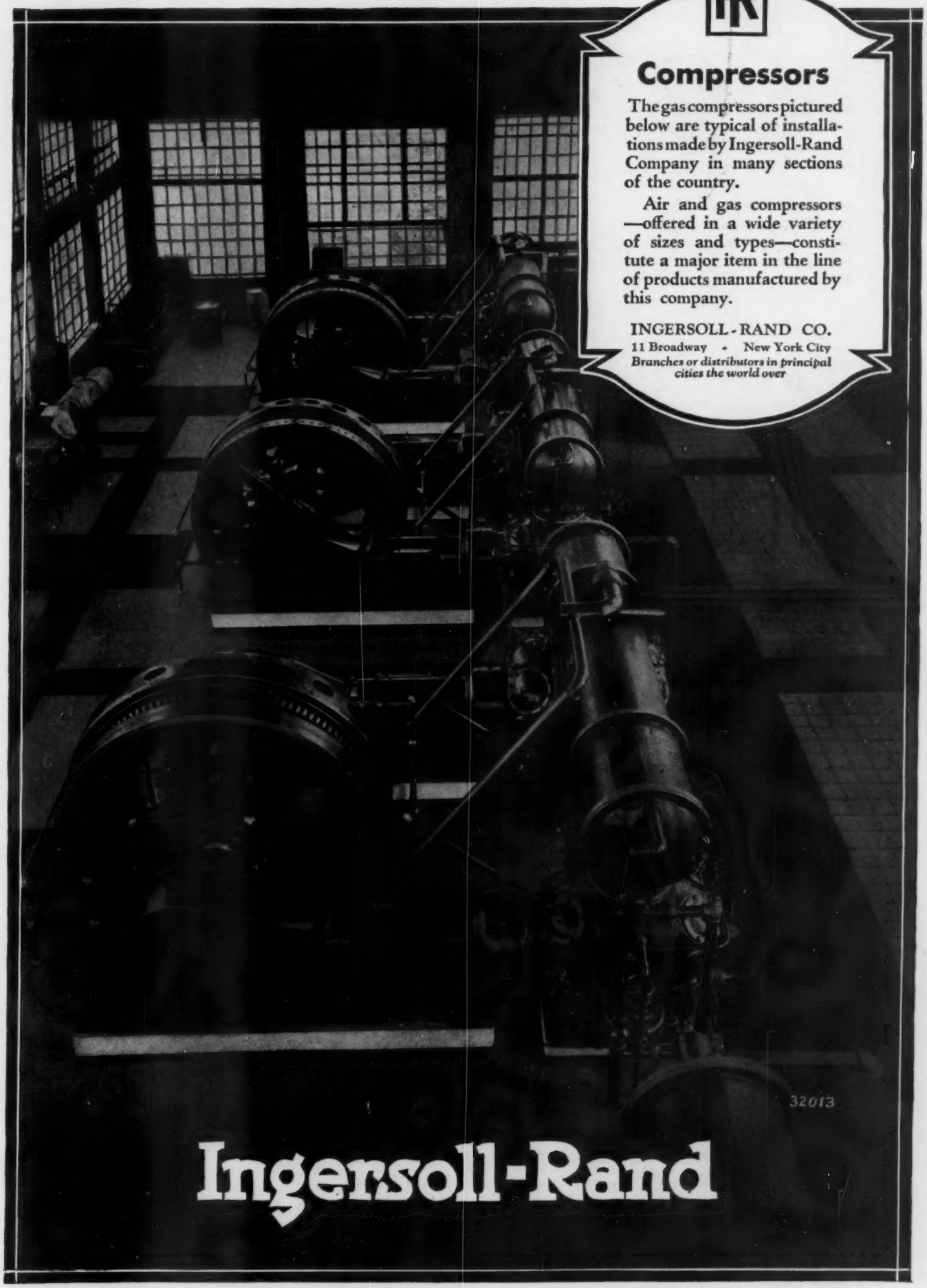

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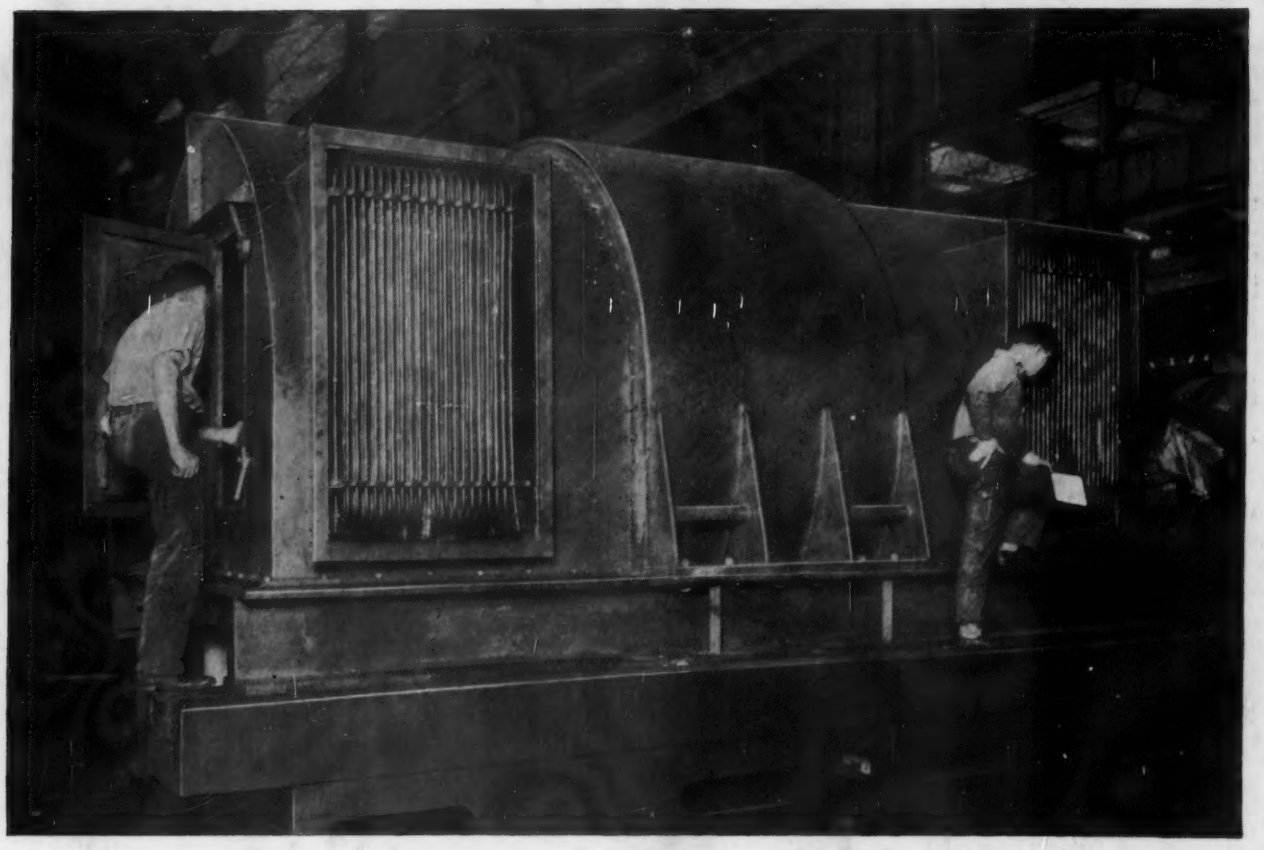

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